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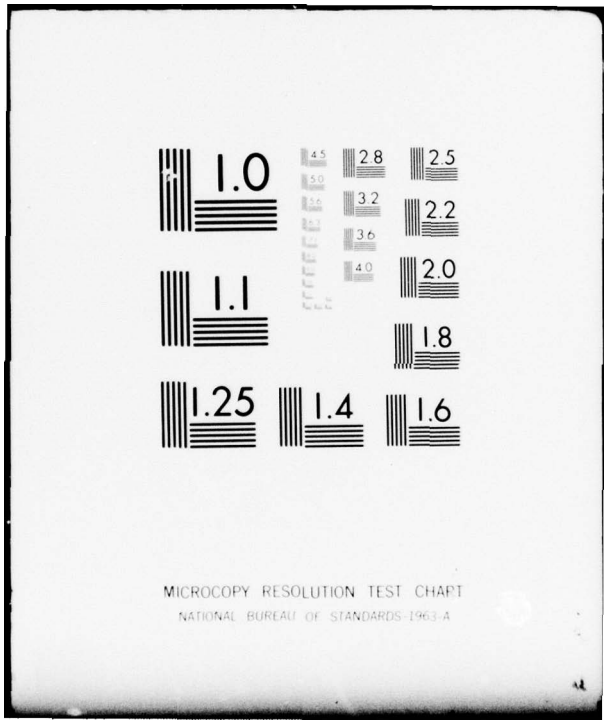
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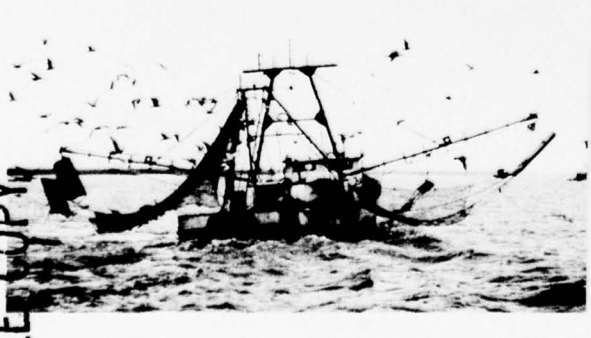

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Appendix K

M and I Water Supply

1974

This appendix is one of a series of 22 documents comprising the complete Lower Mississippi Region Comprehensive Study. A list of the documents is shown below.

Main Report

Appendixes

Appendix	Description	Appendix	Description
A	History of Study	K	M and I Water Supply
B	Economics	L	Water Quality and Pollution
C	Regional Climatology Hydrology & Geology	M	Health Aspects
D	Inventory of Facilities	N	Recreation
E	Flood Problems	O	Coastal and Estuarine Resources
F	Land Resources	P	Archeological and Historical Resources
G	Related Mineral Resources	Q	Fish and Wildlife
H	Irrigation	R	Power
I	Agricultural Land Drainage	S	Sediment and Erosion
J	Navigation	T	Plan Formulation
		U	The Environment

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Appendix K.

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COORDINATING COMMITTEE

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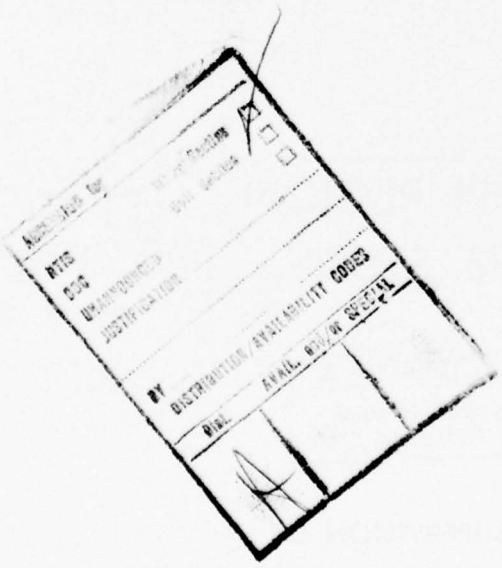
This report was prepared at field level by the Lower Mississippi Region Comprehensive Study Coordinating Committee and is subject to review by interested Federal agencies at the departmental level, by Governors of the affected States, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.



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INTRODUCTION

PURPOSE

This appendix is one of a series of appendixes presenting water data and information for the Lower Mississippi Region Comprehensive Study. Its purpose is threefold: (1) to quantify 1970 water withdrawals for municipal and industrial use, for thermoelectric power production and for rural domestic use in the Lower Mississippi Region, (2) to project the quantified withdrawals to 1980, 2000, and 2020 under the study's long-term objectives, National Income (Program A) and Regional Development (Program B), and (3) to determine probable water-shortage areas in the region from a municipal, industrial, and thermoelectric power standpoint, and suggest, in general, possible methods of relief.

SCOPE

In this appendix, water withdrawals from ground and from surface sources, fresh and brackish, have been quantified and projected by water resource planning areas (WRPA's) and subareas, for the 50-year period of study from 1970 to 2020.

It should be noted that municipal use, as classified in this appendix, is water supplied by public water systems, and does not include rural domestic water use, which is covered as a separate category.

Data on water use used in the preparation of this Appendix was obtained from several sources, and in some instances, the data presented may vary in detail from that published from other sources, due to difference in methods of compilation and reporting. However, the data believed to be the more reliable was used in this Appendix and was considered to reflect the water use information in the bulk of the overall sources.

PRESENTATION OF DATA

The data and information in this appendix are presented for the region as a whole in the Regional Summary, and for each of the WRPA's in more detail under their respective sections.

RELATION TO OTHER APPENDIXES

The various appendixes in the Lower Mississippi Region Comprehensive Study are interrelated and interdependent. This appendix is related to the other appendixes, particularly Economics; Regional Climatology, Hydrology and Geology; and Power, for basic data on population, economy, and water use and requirements for various purposes. Data developed in this appendix on water use and requirements for municipal and industrial purposes are reflected in other appendixes; such as Water Quality and Pollution; Health Aspects; and Recreation.

REGIONAL SUMMARY

STUDY AREA DESCRIPTION

General

The Lower Mississippi Region Comprehensive Study area includes the drainage area of the Mississippi River below the mouth of the Ohio River, except for the Arkansas, Red, and White Rivers above the effects of Mississippi River backwater. The study area also includes the Louisiana coastal marshes between the eastern drainage divide of the Sabine River and the western drainage divide of the Pearl River, and the flood protected area at Cairo, Ill. (see Figure 1).

Principal river basins in the Lower Mississippi Region, other than the Mississippi River backwater reaches of the Arkansas, Red, and White Rivers mentioned above, are the St. Francis, Yazoo, Ouachita-Black, Big Black, Calcasieu, and the Atchafalaya.

The area under study, which is approximately 102,400 square miles or 65.54 million acreas, is composed of 10 water resource areas which lie in parts of seven States, involving small portions of the States of Illinois, Kentucky, and Tennessee; larger portions of the States of Arkansas and Mississippi; and most of the State of Louisiana (the area outlined in black on Figure 1). This area, combined with the Upper Mississippi River Basin, makes up the third-largest drainage area in the world. The overall basin lies in portions of 31 States and a small portion of Canada. The Mississippi River drains approximately 41 percent of the conterminous United States. Data gathering for this appendix conformed to the county line boundary outlined in blue in Figure 1. (See Methodology for supporting rationale).

Topography

The alluvial valley of the Lower Mississippi Region is a broad, gently sloping lowland which begins below Cape Girardeau, Mo., at approximate latitude 37° N., extends more than 600 miles south to approximate latitude 29° N., and varies in width from 30 to 125 miles.

As mentioned, relief of the alluvial valley is minor and rises from the extensive marshes and swamps near m.s.l. (mean sea level) at the Louisiana coast to nearly 300 feet above m.s.l. at the northern end of the study area. The more prominent topographical features include the loessial hills occurring along much of the eastern edge of the alluvial valley, the Ouachita Mountains in the headwater reaches of WRPA 5, and the foothills of the Ozark Mountains along the northwestern part of the WRPA 2.

Population

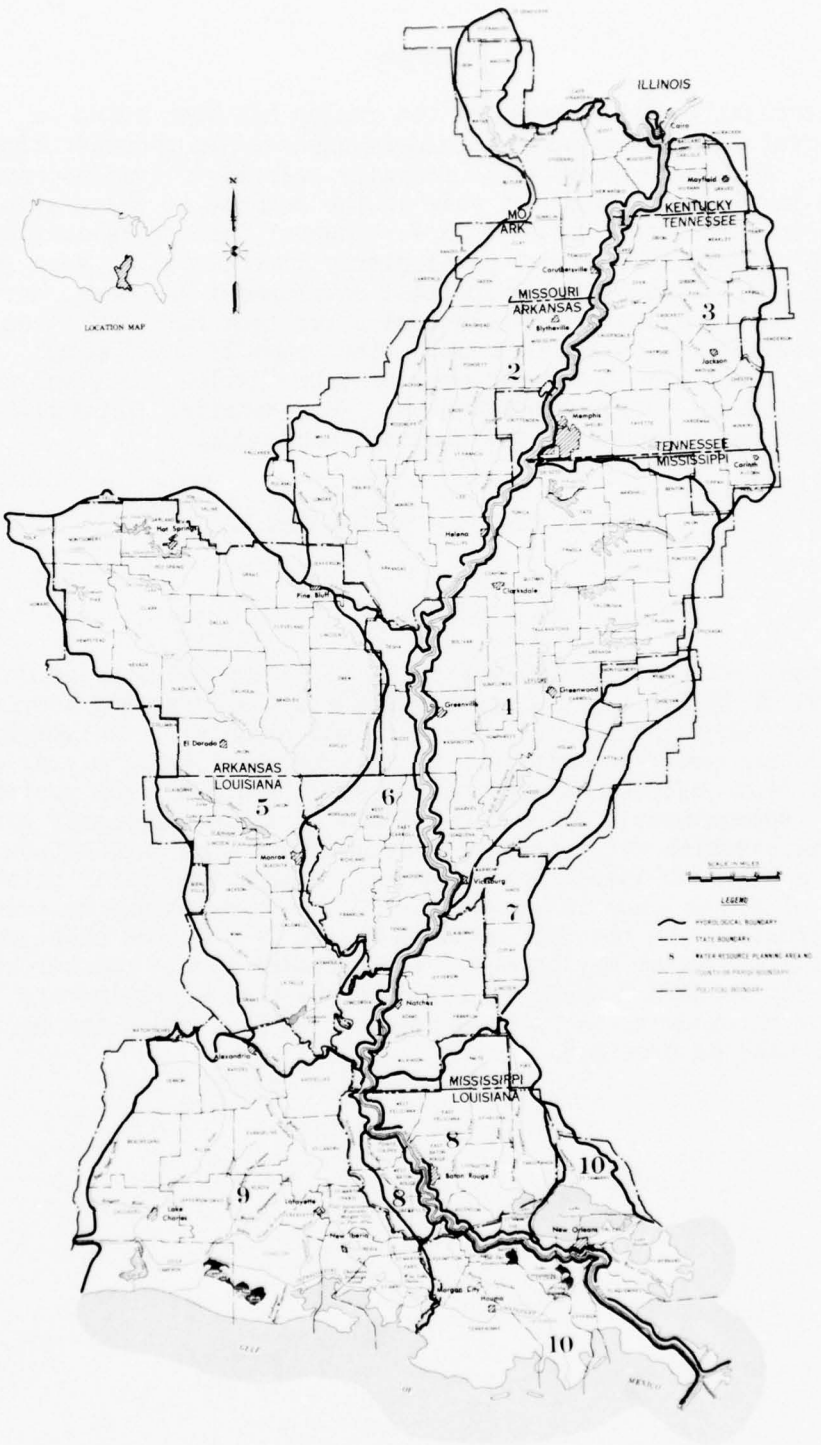
The total population of the Lower Mississippi Region, according to the 1970 U.S. Census, is 6,293,233. The three major cities in the study area, Memphis, Baton Rouge, and New Orleans, are all located on the Mississippi River, and have urban populations of 623,530, 165,963, and 593,471, respectively (1970 U.S. Census). Smaller cities located on the main stem are Greenville, Vicksburg, and Natchez, Miss., with populations of 39,648, 24,478, and 19,708, respectively. Other cities in the study area, but not on the main stem, include Pine Bluff, Hot Springs, and El Dorado, Ark., with 1970 U.S. Census populations of 57,389, 36,631, and 25,283, respectively; and Lake Charles, Monroe, and Alexandria, La., with populations of 77,998, 56,374, and 41,557, respectively. The population of the region is 43 percent rural (2,567,930) and 57 percent urban (3,734,123), and indications are that urbanization will increase.

Climate

The climate in the Lower Mississippi Region is generally temperate in the upper portion and semitropical in the lower reaches, with summers generally long, hot, and humid; and winters short and moderate. Average annual temperatures range from 60° F. in the upper region to 70° F in the lower region. The corresponding average daily temperatures are 40° F. to 55° in January, and 80° F. to 82° F. in July.

Precipitation is abundant and well distributed in the Lower Mississippi Region. Normal annual precipitation ranges from 44 inches in the upper most portion of the region, to 64 inches near the mouth of the Mississippi River. The annual mean number of days of precipitation ranges from 100 in the western portion to 110 in the eastern portion. Absolute and relative humidity is high, producing sultry weather for a considerable portion of the time.

The Region is subject to torrential rains and high-intensity winds generally between May and the latter part of October, which is considered the hurricane season. Considerable property losses have occurred due to flooding and wind damages, lives have been lost, and municipal and industrial water supply systems have been disrupted. The hurricanes tend to spawn tornadoes, which usually increase havoc wrought by the hurricanes themselves. More detailed information of this nature may be found in the Regional Climatology, Hydrology and Geology Appendix.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

REGIONAL MAP

FIGURE 1

Economy

Historically, the economy of the region has been based on agricultural activities, with secondary emphasis on manufacturing and industry. Agriculture and agriculturally related activities have played a particularly dominant role in the economy of the region and still do in some areas, as in WRPA 4. However, industrial activities have been rapidly increasing, particularly in the coastal area (WRPA's 8, 9, and 10). Much of the industrial development has been, and continues to be, along the Mississippi River from north of Baton Rouge to some distance below New Orleans. Other rapidly developing industrial areas are in the vicinity of Lake Charles, La., and on the Mississippi River in the Memphis area. More detailed information of this nature may be found in the Economics Appendix.

PRESENT STATUS - 1970 WATER USE

General

In the Lower Mississippi Region in 1970, a total average daily withdrawal of 10,692.6 m.g.d. from surface and underground sources was made for municipal, rural domestic, and industrial use and for thermoelectric power generation. Of this total, 1,427.2 m.g.d. was withdrawn from underground sources and 9,265.4 m.g.d. from surface sources. Approximately 13 percent of the total average daily withdrawal was brackish water drawn almost entirely from surface sources, and used mostly for industrial purposes. Underground water below the latitude of New Orleans is very likely to be brackish due to salt-water intrusion from the Gulf of Mexico. It is expected that greater use of brackish water may be made in the future in the coastal WRPA's, particularly in WRPA 9 where it is projected that approximately 79 percent of the industrial water withdrawal in 2020 under the Regional Objective will be brackish.

Municipal Water Use

Total water withdrawn in 1970 for municipal use in the Region amounted to 616.7 m.g.d., with the lowest withdrawal occurring in WRPA 6, which is approximately 61 percent rural, and the highest withdrawal, 184.7 m.g.d. in WRPA 10, which is approximately 83 percent urban (see Table 1). Of the 616.7 m.g.d. withdrawn for municipal use, 206.0 m.g.d., or approximately 34 percent, was from streams, and 410.7 m.g.d., or approximately 66 percent, was from underground sources. The average daily per capita use in the WRPA's ranged from 78 g.p.d. in WRPA 6, one of the more rural and less populous areas, to 164 g.p.d. in WRPA 10, which is the most urbanized area. Consumption has been assumed to be 37 percent, a realistic figure for municipalities.

Two-thirds of the water withdrawn for municipal purposes, was from underground sources, generally of good quality and required relatively little treatment, such as chlorination, aeration, and iron removal. The remaining one-third was from streams and required more extensive treatment, usually coagulation, sedimentation, filtration, taste and odor removal, and sterilization.

Throughout the region, an average of 63 percent of water withdrawn for municipal purposes was returned to streams. The 37 percent not returned is considered consumed and involves water losses in lines as leakage, evaporation, water used in lawn sprinkling, firefighting, etc.

No significant shortage of municipal water was experienced in the region in 1970 either from underground or from surface sources.

Industrial Water Use

In 1970, a total of 5,419.8 m.g.d. was withdrawn to supply all the WRPA's in the region with water for industrial purposes. The lowest withdrawal, 61.5 m.g.d., was in WRPA 6 which has relatively few industries (none of which are major water consumers) and the highest withdrawal, 2,038.8 m.g.d., was in WRPA 10. This is the most industrialized WRPA, and most of its industries require large amounts of water in their processes and for cooling (see Table 1).

Of the 5,419.8 m.g.d. withdrawn for industrial use in the region, 4,598.2 m.g.d., or approximately 85 percent, was from surface sources; 821.6 m.g.d., or approximately 15 percent, was from underground sources. Approximately 20 percent of the total withdrawal for industrial use, 1,065.2 m.g.d. was brackish water almost entirely from surface sources. Practically all of the brackish water was used in WRPA's 9 and 10, which occupy the coastal region of Louisiana, and much of this water was used in cooling processes. WRPA 9, which includes the industrial complex in the Lake Charles, La., area, used approximately 96 percent,

Table 1 - 1970 Regional Water Use[1/]

WRPA Source	Municipal		Industrial		Power[2/]		Rural	Total
	Ground	Surface	Ground	Surface	Ground	Surface	Ground	
2	32.7	2.1	33.7	5.1	5.0	394.0	24.7	497.3
3	141.8	0.0	94.6	3.5	0.0	430.0	19.3	689.2
4	53.8	0.0	49.1	37.5	31.1	273.9	21.7	467.1
5	37.5	16.8	119.3	87.4	0.3	1,070.7	16.1	1,348.1
6	7.5	0.6	28.4	33.1	0.3	0.0	6.7	76.6
7	12.0	0.0	73.1	0.5	1.0	0.0	5.2	91.8
8	54.5	0.7	159.3	1,354.9	8.8	579.6	4.5	2,162.3
9	65.1	6.9	237.8	1,063.7	8.5	328.0	16.8	1,726.8
10	5.8	178.9	26.3	2,012.5	21.4	1,385.0	3.5	3,633.4
Total	410.7	206.0	821.6	4,598.2	76.4	4,461.2	118.5	10,692.6

[1/] Daily average withdrawal in m.g.d.

[2/] Figures indicated for thermoelectric power use are primarily figures submitted by U.S. Geological Survey with some adjustment where better information was available. Federal Power Commission figures for 1970 water use were considered incomplete since all power generation stations are not required to submit FPC Form 67.

1,024.3 m.g.d., of the brackish water withdrawn in the region.

Approximately 73 percent, or 3,367.4 m.g.d., of the surface water withdrawn for industrial use in the region, was used in WRPA's 8 and 10 and was withdrawn from the Mississippi River, which runs through the entire length of both WRPA's which are highly industrialized along most of that length of stream. Since practically two-thirds of the water withdrawn in the region for industrial purposes is from surface sources, 73 percent of which is from the Mississippi River, some degree of treatment was applied, depending upon its use and/or the type product manufactured. Food-processing industries require water to be treated to meet drinking-water standards, while some industries requiring water mostly for cooling purposes may need only pH adjustment or anti-corrosion treatment. Of the water withdrawn in the region for industrial purposes, return flows may vary from approximately 60 percent to 97 percent depending on the type industry and product manufactured.

There was no known water shortage for industrial purposes in the region in 1970.

Thermoelectric Power Water Use

Water withdrawn in 1970 for thermoelectric power generation in the Region amounted to 4,537.6 m.g.d. This was considered as used exclusively for condenser-cooling purposes since boiler feed water requirements constitute a very small portion of the total water requirement for power generation. The lowest withdrawal, 0.3 m.g.d., was in WRPA 6, which has only one relatively small power plant using ground water with cooling towers and recirculation facilities. The highest withdrawal occurred in WRPA 10, which has six large plants drawing 1,406.4 m.g.d. mostly from streams. Surface water sources, both fresh and brackish, accounted for 4,461.2 m.g.d., or 98.3 percent of the withdrawal for thermoelectric power generation. Ground water withdrawal for thermoelectric power generation in plants having cooling and recirculating facilities amounted to 76.4 m.g.d., or 1.7 percent of the total withdrawal.

The quality of the water used in the Lower Mississippi Region for condenser cooling purposes is not of particular concern and no treatment is applied, except in isolated cases where pH adjustment and anti-corrision measures may be desirable to prolong the life of the equipment and accessories involved.

No water shortage for thermoelectric power generation in 1970 is known to have occurred in the Lower Mississippi Region. It should be noted that power plants withdrawing water for cooling purposes actually consume little of the water withdrawn (averaging less than 1 percent in most plants). The remainder is recirculated or returned to the surface

source. This water consumption represents losses due mostly to evaporation and drift where cooling facilities are used, and represents line losses in plants using a "once-through" cooling system.

Rural Domestic Water Use

Water withdrawn in 1970 for rural domestic use in the region amounted to 118.5 m.g.d., or 1.1 percent of the total water withdrawal. (See Table 1). This 118.5 m.g.d. is withdrawn by rural residents from individually owned wells, and does not represent the total water use of the rural population. A sizeable portion of the rural population is served by the extension of nearby municipal systems, Farm and Home Administration systems, or other public systems. This water usage has been classed as municipal water use, as pointed out in Scope under Introduction.

All of the water withdrawn for rural domestic use was from underground sources in 1970 and all of this water is considered consumed.

FUTURE NEEDS

Municipal Water Needs

Municipal water requirements in the Lower Mississippi Region are expected to increase by approximately 149 percent during the study period (1970 - 2020) under the National Income Objective, and by approximately 185 percent for the corresponding period under the Regional Development Objective. Varying percentage increases are expected within the individual WRPA's. For example, the largest increase, 188 percent under the National Income Objective and 235 percent under the Regional Development Objective, is expected in WRPA 3 which for the purposes of this appendix contains the Memphis Standard Metropolitan Statistical Area (SMSA). The lowest increase, 81 percent under the National Income Objective and 100 percent under the Regional Development Objective, is expected in WRPA 6, which is one of the more rural and less populous areas. Tables 2 and 3 show future regional municipal water needs under the National Income and Regional Development Objectives.

The increase in municipal water requirements expected over the study period will be due to one or more of the following factors: increased population, increased urbanization, and increased per capita consumption due to the higher level of affluence, which generally accompanies increases in urbanization. The increase in urbanization is the more influential factor in the projected increase in municipal water requirement. This is borne out in the Economics Appendix, which

indicates the urbanization in WRPA 3 will increase from 70 percent in 1970 to 88 percent in 2020. Urbanization in WRPA 6 is expected to increase from 39 percent in 1970 to 53 percent in 2020, and from 83 percent in 1970 to 85 percent in 2020 in WRPA 10, which contains the New Orleans SMSA. In WRPA 8, the Baton Rouge SMSA, which is expected to experience the next largest increase in municipal water requirement, the urbanization is projected to increase from 58 percent in 1970 to 73 percent in 2020.

Industrial Water Needs

Water requirements for industrial purposes in the Lower Mississippi Region are expected to increase by approximately 770 percent during the period of study under the National Income Objective, and by approximately 927 percent during the same period under the Regional Development Objective (Tables 4 and 5). The largest individual increase, 814 percent under the Natioanl Income Objective and 978 percent under the Regional Development Objective, is expected in WRPA 8, which includes the Baton Rouge SMSA. This area is followed closely by WRPA 10, which contains the New Orleans SMSA, with an increase of 804 percent under the National Income Objective and 966 percent under the Regional Development Objective, and by WRPA 3, which includes the Memphis SMSA, with an increase of 716 percent under the National Income Objective and 862 percent under the Regional Development Objective. These figures are indicative of the continued rapid industrial development that can be expected along the main stem from above Baton Rouge to below New Orleans, La., and also on the main stem in the Memphis area. The lowest increase in industrial water requirements for the study period is expected in WRPA 6 with a 325 percent increase under the National Income Objective and 399 percent under the Regional Development Objective. This is in keeping with the fact that WRPA 6 is primarily an agricultural area and is, along with WRPA 7, among the less populous and more rural areas in the region.

The largest and most important industries require tremendous amounts of water of relatively good quality for process and/or cooling purposes. In the past, the Mississippi River has been considered an almost inexhaustible source of good-quality water, which accounts for the present large degree of industrialization along the river.

Thermoelectric Power Water Needs

Thermoelectric water-use requirements in the Lower Mississippi Region are expected to increase by 417 percent during the study period under the National Income Objective, and by 488 percent during the same period under the Regional Development Objective. (Tables 6 and 7 show the future regional thermoelectric water needs.) The tremendous in-

Table 2 - Future Regional Water Needs - Municipal[1/]
National Income Objective (Program A)

WRPA	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2	40.1	14.7	56.6	21.2	82.6	30.9
3	175.7	64.6	278.1	103.3	408.8	152.3
4	65.7	24.2	89.8	33.4	123.7	46.1
5	65.9	24.2	89.8	33.4	133.8	49.9
6	9.1	3.4	11.4	4.2	14.7	5.5
7	15.3	5.6	22.1	8.2	32.8	12.2
8	72.1	26.5	108.6	40.4	157.5	58.8
9	92.0	33.7	126.2	47.0	167.7	62.5
10	220.3	81.1	310.1	115.3	428.2	159.7
Total	756.2	278.0	1,092.7	406.4	1,549.8	577.9

Table 3 - Future Regional Water Needs - Municipal[1/]
Regional Development Objective (Program B)

WRPA	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2	43.1	15.8	63.4	23.6	96.1	35.9
3	192.9	71.0	316.0	117.5	474.5	176.8
4	71.9	26.4	101.8	37.8	140.4	52.4
5	70.0	25.8	101.9	37.9	152.2	56.8
6	9.8	3.6	11.9	4.4	16.2	6.1
7	17.0	6.2	25.7	9.5	38.3	14.3
8	77.7	28.6	121.5	45.2	178.8	66.7
9	98.2	36.2	142.9	53.3	188.9	70.6
10	237.8	87.5	345.9	128.7	485.9	181.2
Total	818.4	301.1	1,231.0	457.9	1,771.3	660.8

[1/] All figures are daily averages in m.g.d.

Table 4 - Future Regional Water Needs - Industrial[1/]
National Income Objective (Program A)

WRPA	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2	58.3	23.5	142.8	57.2	332.0	132.9
3	149.5	22.2	351.2	52.0	800.6	118.5
4	135.5	9.9	320.4	21.6	729.3	46.6
5	307.4	101.0	683.9	224.5	1,497.8	486.0
6	71.3	8.3	135.9	17.1	261.3	35.0
7	105.5	10.1	235.0	24.3	509.1	55.3
8	2,261.3	627.5	5,668.5	1,771.6	13,840.9	4,487.1
9	2,047.4	347.8	4,745.0	771.7	10,780.8	1,676.7
10	3,072.1	157.7	7,707.8	359.2	18,426.5	805.1
Total	8,208.3	1,308.0	19,990.5	3,299.2	47,178.3	7,843.2

Table 5 - Future Regional Water Needs - Industrial[1/]
Regional Development Objective (Program B)

WRPA	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2	64.0	25.6	164.8	65.8	391.2	156.4
3	163.8	24.1	398.1	58.6	944.2	139.6
4	148.6	10.9	370.6	25.1	859.7	54.9
5	345.9	115.3	808.5	266.5	1,803.5	589.0
6	78.9	9.3	157.2	19.8	306.8	41.2
7	114.9	10.5	263.0	25.5	575.1	57.6
8	2,480.2	687.8	6,548.8	2,049.1	16,322.3	5,292.0
9	2,244.8	381.3	5,486.6	895.3	12,714.3	1,977.5
10	3,367.1	172.8	8,915.0	415.3	21,731.4	949.2
Total	9,008.2	1,437.6	23,112.6	3,821.0	55,648.5	9,257.4

[1/]All figures are daily averages in m.g.d.

crease in water requirements for thermoelectric power generation expected in WRPA's 6 and 7 is due to the fact that these WRPA's presently draw all or most of their power requirements from other areas through the interconnected systems of Southwest Power Pool members, but by the year 2020 are expected to have power generation facilities to meet their needs within their own respective areas. The largest "normal" increase in water requirements for power generation is expected in WRPA 8, the Baton Rouge SMSA, where an 858-percent increase under the National Income Objective and 987 percent under the Regional Development. Objective is indicated. It should be noted that WRPA 8 is also the area expected to show the greatest increase in industrial water requirements, as indicated in the previous section. The lowest increase in water requirements for thermoelectric power generation is expected in WRPA 2, where an increase of 92 percent under the National Income Objective and 123 percent under the Regional Development Objective is expected to satisfy their needs by the year 2020. Power requirements for the region are covered in more detail in the Power Appendix.

Rural Domestic Water Needs

Water requirements for rural domestic purposes in the Lower Mississippi Region, are expected to decline during the study period by approximately 40 percent under the National Income Objective, and by approximately 26 percent under the Regional Development Objective (Tables 8 and 9). The greatest decline is expected to occur in WRPA 5 with approximately 66 percent under the National Income Objective and approximately 61 percent under the Regional Development Objective. In general, as indicated in Tables 8 and 9, a decline is expected in WRPA's 2 through 7 and in WRPA 9 due mostly to increased urbanization, further extension of municipal systems, and creation of more water districts and Farm and Home Administration systems. Tables 8 and 9 further indicate an increase in rural domestic water requirements in WRPA's 8 and 10 under both programs. This increase in rural domestic water requirements is due to the fact that WRPA's 8 and 10 are already highly urbanized and will not experience as great an increase in urbanization as in the remaining WRPA's, while per capita use in the rural areas of WRPA's 8 and 10 will be greatly increased due to nearby urban influence.

Rural domestic water requirements amount to 1 percent or less of the total municipal, industrial, thermoelectric, and rural requirements.

SUMMARY OF WATER NEEDS

A summary of the total water needs of the region for municiapl,

Table 6 - Future Regional Water Needs - Thermoelectric Power[1/]
National Income Objective (Program A)

WRPA	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2	399.0	2.5	641.5	7.7	766.4	12.1
3	549.9	8.9	1,565.6	18.7	1,981.6	31.3
4	995.2	10.6	995.2	10.6	1,107.3	14.7
5	1,071.0	9.8	2,905.2	34.6	3,441.6	54.3
6	82.3	0.9	547.8	6.5	649.8	10.3
7	55.9	0.5	397.6	5.2	473.2	7.5
8	1,257.7	46.5	4,747.1	64.3	5,634.0	92.8
9	651.1	26.3	2,520.1	30.6	3,180.1	58.4
10	2,058.8	105.6	5,184.8	105.6	6,229.2	105.6
Total	7,120.9	211.6	19,504.9	283.8	23,463.2	387.0

Table 7 - Future Regional Water Needs - Thermoelectric Power[1/]
Regional Development Objective (Program B)

WRPA	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2	399.0	2.5	718.5	8.6	889.1	14.0
3	633.6	9.9	1,780.0	21.2	2,300.5	36.3
4	995.2	10.6	1,045.4	12.5	1,257.9	19.8
5	1,071.0	9.8	3,294.5	39.3	3,916.5	61.8
6	97.1	1.0	575.1	6.9	713.5	11.3
7	73.6	0.8	462.8	3.7	554.1	8.7
8	1,396.1	48.0	5,316.8	72.0	6,394.7	105.3
9	718.3	27.1	2,856.8	34.6	3,582.3	65.8
10	2,242.0	107.5	5,781.1	107.5	7,070.1	118.0
Total	7,625.9	217.2	21,831.0	306.3	26,678.7	440.0

[1/]All figures are daily averages in m.g.d.

Table 8 - Future Regional Water Needs - Rural Domestic[1/]
National Income Objective (Program A)

WRPA	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2	20.6		16.0		10.6	
3	20.0		14.3		11.9	
4	18.9		14.7		11.1	
5	14.4		12.2		5.5	
6	5.2		3.9		2.7	
7	4.6		3.4		1.9	
8	4.9		6.1		8.4	
9	15.1		14.7		14.7	
10	5.4		6.2		5.1	
Total	109.1		91.5		71.9	

Table 9 - Future Regional Water Needs - Rural Domestic[1/]
Regional Development Objective (Program B)

WRPA	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2	22.3		17.7		12.2	
3	22.0		16.2		13.9	
4	20.6		16.7		12.6	
5	15.3		13.9		6.3	
6	5.6		4.0		2.9	
7	5.1		4.0		2.2	
8	5.3		6.9		9.5	
9	16.1		16.7		16.5	
10	5.8		7.0		5.7	
Total	118.1		103.1		81.8	

[1/] All figures are daily averages in m.g.d. Rural domestic water considered 100 percent consumed.

industrial, rural domestic, and thermoelectric power generation for 1970 and for each of the target years under the National Income and Regional Development Objectives is given in Table 10.

The total water needs for municipal, industrial, and power generation purposes are expected to increase during the study period, 1970-2020, by approximately 582 percent under the National Income Objective, and by approximately 695 percent under the Regional Development Objective. Due to the decline in the rural domestic water needs, the overall regional needs however will increase by 576 percent and 687 percent under the National Income and Regional Development Objectives, respectively.

Table 10 - Summary of Regional Water Needs[1/]

Need	1970	1980		2000		2020	
		National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Municipal	616.7	756.2	818.4	1,092.7	1,231.0	1,549.8	1,771.3
Industrial	5,419.8	8,208.3	9,008.2	19,990.5	23,112.6	47,178.3	55,648.5
Thermoelectric Power	4,537.6	7,120.9	7,625.9	19,504.9	21,831.0	23,463.2	26,678.7
Rural Domestic	118.5	109.1	118.1	91.5	105.1	71.9	81.8
Total Region	10,692.6	16,194.5	17,570.6	40,679.6	46,367.7	72,263.2	84,180.3

[1/] Daily average withdrawals in m.g.d.

METHODOLOGY

GENERAL

The Lower Mississippi Region is one of 18 regions in the conterminous United States defined by the Water Resources Council for the purpose of appraising overall water and related land resources development needs. In order to define these needs more closely, the Lower Mississippi Region was further divided, in accordance with its several river basins, into 10 water resource planning areas developed along hydrologic lines.

Much of the data contained herein were gathered on county or parish lines rather than strict hydrologic lines for ease in compilation of data traditionally expressed on political boundaries. In some cases adjustments were also made in boundaries between WRPA's to more realistically define needs. As shown in Appendix B, Economics, major adjustments of this type were: Crittenden County, Arkansas, was included in WRPA 3 because it is part of the Memphis SMSA. Over 95 percent of the Memphis SMSA development and population is on the Tennessee side of the Mississippi River, data are readily available for the total SMSA, and the bulk of future SMSA development is expected to occur in WRPA 3.

The boundary between WRPA's 5 and 9 was adjusted for this appendix to include Rapides and Avoyelles Parishes in WRPA 9 because of the location of the Alexandria SMSA (Appendix B, Economics, includes Rapides and Avoyelles Parishes in WRPA 5).

MUNICIPAL WATER NEEDS

The methodology used in the development of municipal water needs is based on: (1) the 1970 (base year) pumpage for municipal use, (2) the population served by the 1970 pumpage, to develop a gallon per capita per day (GPCD) coefficient, (3) projection of the population served by municipal systems, and (4) the projection of the per capita requirements of the population served by municipal systems.

It should be noted that the term municipal systems, as used in this text, includes all legally established systems.

The 1970 pumpage, in m.g.d., for municipal use in the study area was developed from data provided by the U.S. Geological Survey (USGS), Public Service Research (PSR), State surveys, and other sources, such as direct inquiry when USGS and PSR data were not available. In the portions of WRPA 2 and WRPA 5 located in the State of Arkansas, the 1970 pumpage for municipal use was developed by the Gulf South Research Institute (GSRI) from projections of its 1967 figures determined for

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use in the West Texas and Eastern New Mexico Water Import Study. The population served was provided along with the pumpage, and the present GPCD rates were developed for each subarea in each WRPA. The 1970 U.S. Census data were used to determine the population of each subarea and the ratio of population served by public systems to total population obtained for each subarea. This ratio was assumed in this study to increase by straight-line projection to 100 percent by the target year 2020 for SMSA's, and to 80 percent for non-SMSA's.

WRPA population figures for all projection years were provided by the Economics Subcommittee, disaggregated into subareas, and the percent share of each subarea within a WRPA determined. This percentage was used to distribute the projected populations for 1980, 2000, and 2020 in each WRPA. Population served by public systems in each subarea was then obtained by application of the ratio of population municipally served to the total population, developed as explained in the previous paragraph.

In developing the projected GPCD rates, use was made of the results obtained from the application of the Main II system (a system developed by Hittman Associates, Inc. of Maryland) by GSRI in its study for the Mississippi River Commission in connection with the water requirements for the West Texas and Eastern New Mexico Water Import Study. The growth index of the GPCD rates developed in that study was applied to the GPCD rates in each subarea of each WRPA in the present study. The product of the projected population municipally served and the corresponding GPCD rate resulted in the estimated projected municipal water needs. A uniform consumption coefficient of 37 percent, as established in the West Texas and Eastern New Mexico Water Import Study, was used throughout the study area in this appendix.

INDUSTRIAL WATER NEEDS

Estimates of industrial water needs for this study were based primarily on data obtained from an industrial water-usage survey of industries within the study area conducted by GSRI for the Mississippi River Commission in the West Texas and Eastern New Mexico Water Import Study. The following information was obtained from that survey:

a. Location and identification of the industry.

b. Economic data (employment, production volume, production value).

c. Water intake and recirculation (by month).

d. Water source, whether ground, surface, or purchase (if surface, the name of the stream).

e. Water usage (cooling, boiler feed, processing and sanitary).

f. Return flow or discharge (by month).

The Standard Industrial Classification (SIC) system developed by the U.S. Department of Commerce was used to identify and classify industries reporting on the survey. SIC classification is divided into two-, three-, and four-digit levels. The two-digit level is a general classification of industry by type, such as SIC 26 - Paper and Allied Products, while the three- and four-digit groupings are more specific subdivisions of the two-digit groups, such as 264 - Converted Paper Board Products, and 2643 - Bags. Water requirements were examined on a four-digit basis, water-requirement coefficients were developed on a three-digit level, and water requirements were summarized at the two-digit major water-users level for this study. This data was supplemented by more current data collected by the States and the U.S. Geological Survey.

A computer program requiring the following input was developed to calculate present and projected water-requirement coefficients at a three-digit level:

a. Present base-year and projected employment for each three-digit SIC in each WRPA.

b. Coefficients (water use per employee per given time period for the base year, and adjusted for productivity for the project years).

c. Monthly intake and return-flow distribution.

Base year coefficients of water use were developed on a subarea level. The coefficients were developed by summing all three-digit SIC water use for an area and dividing the sum by the number of employees involved. This calculation produced a coefficient in gallons per employee for the base year.

Projected industrial coefficients were developed by adjusting the base-year coefficient for changes in productivity, since water requirements are a function of productivity as well as employment. Estimates of employment for the projection years (developed in the economic study using Office of Business Economics (OBE) methodology) and productivity were used to adjust water use coefficients over time. The principal calculation of the program then was employment times the base year water-use coefficient adjusted over time for productivity change; or, total water requirement = employment x base year coefficient x productivity index.

THERMOELECTRIC POWER WATER NEEDS

Water requirements for power generation were obtained from the Federal Power Commission (FPC) regional office in Ft. Worth, Tex., and adjusted where appropriate. Data supplied were essentially the same data furnished the Mississippi River Commission for use in the West Texas and Eastern New Mexico Water Import Study. The water withdrawals from streams, wells, or public water systems are used primarily for condenser cooling purposes since water used for other purposes, such as boiler feed water (makeup water), constitute only a very small portion of the total water withdrawn for power generation.

The basic factor used in determining water requirements for power generation is the "energy for load," which the FPC staff compiles annually from reports made by the utility companies of the country. "Energy for load" is the electric energy required to serve the needs of an area, and may or may not be supplied by generating facilities within the area. Needs, as used here, is the electric energy required to power machinery and appliances which are used in maintaining our average standard of living.

For the purpose of this report all electrical energy needs beyond 1980 were considered as generated within the area needed.

USGS data on the actual pumpage for power generation in 1970, adjusted with better information, such as direct inquiry, where available, were used in lieu of FPC data.

For the year 1980, FPC data were adjusted as follows:

a. Where 1970 pumpage reported by USGS exceeded the 1980 needs as determined by FPC, the 1970 pumpage was used.

b. Where the 1970 pumpage (USGS) was much less than the 1970 needs as determined by FPC, the 1980 figure was increased from the 1970 pumpage only in the amount that the FPC data increased between 1970 and 1980. (Plants operating in 1970 were assumed to still be in operation in 1980.)

Beyond the year 1980 FPC data were used as submitted.

Exception to this methodology was made in WRPA 4 where supplementary reports indicated a water use of 895.2 m.g.d. due to added generating units going on line subsequent to the 1970 USGS report.

Water requirements for the generation of the "energy for load" were determined by FPC by application of water-use factors developed from experience in the operation of power generation facilities of all types.

Projected loads and water requirements for their generation, as determined by FPC in consultation with various utility officials, took into consideration the ratio of the various types of generation, including nuclear generation as well as condenser cooling systems (once-through, cooling towers, cooling ponds, etc.).

Cooling water needs for electric power generation were developed by FPC for the Mississippi River Commission and transmitted by letter, dated 24 September 1969, for use in the West Texas and Eastern New Mexico Water Import Study. The boundaries used in that study are very similar to those used in the Lower Mississippi Region Comprehensive Study. The principal difference affecting electric energy is in the boundary between WRPA 5 and WRPA 9, where Rapides and Avoyelles Parishes were shifted from WRPA 5 to WRPA 9, as indicated in the paragraph "General" above. However, the cooling water requirements were adjusted accordingly so that total requirements for the Lower Mississippi Region are the same in each study.

RURAL DOMESTIC WATER NEEDS

Water used for rural domestic purposes generally constitutes only a very small portion of the overall water use in any WRPA, and therefore refinements in methodology were not considered warranted.

The methodology used in determining rural domestic water needs is generally as follows: (a) the difference between the population of any subarea and the population served by public systems in the subarea, as determined in the development of municipal water needs (see Methodology above), was considered the rural population not served by any water system; (b) a uniform water-use coefficient of 80 gallons per capita per day was used for the whole study area and for the entire study period; (c) the product of factors (a) and (b) was used for the rural domestic water use in any given subarea and for any given target year; and (d) for all practical purposes, 100 percent of water withdrawn for rural domestic use was considered as consumed.

W R P A 1

WRPA 1, as indicated on the regional map (Figures 1 and 2), comprises the main stem of the Mississippi River below the mouth of the Ohio River, extending to and including the main stem levees, or to the top of the banks of the stream where levees do not exist.

Other than for navigation, recreation, and fish and wildlife purposes, WRPA 1 has very few, if any, water needs of its own.

For the purpose of this appendix, therefore, WRPA 1 is considered only as a source of water supply and/or a receiving stream for return flows from the WRPA's along its banks, or through which it flows.

WRPA 1 is covered in more detail in the Regional Climatology, Hydrology and Geology; Flood Problems; Navigation; Water Quality and Pollution; Fish and Wildlife; and Sediment and Erosion Appendixes.

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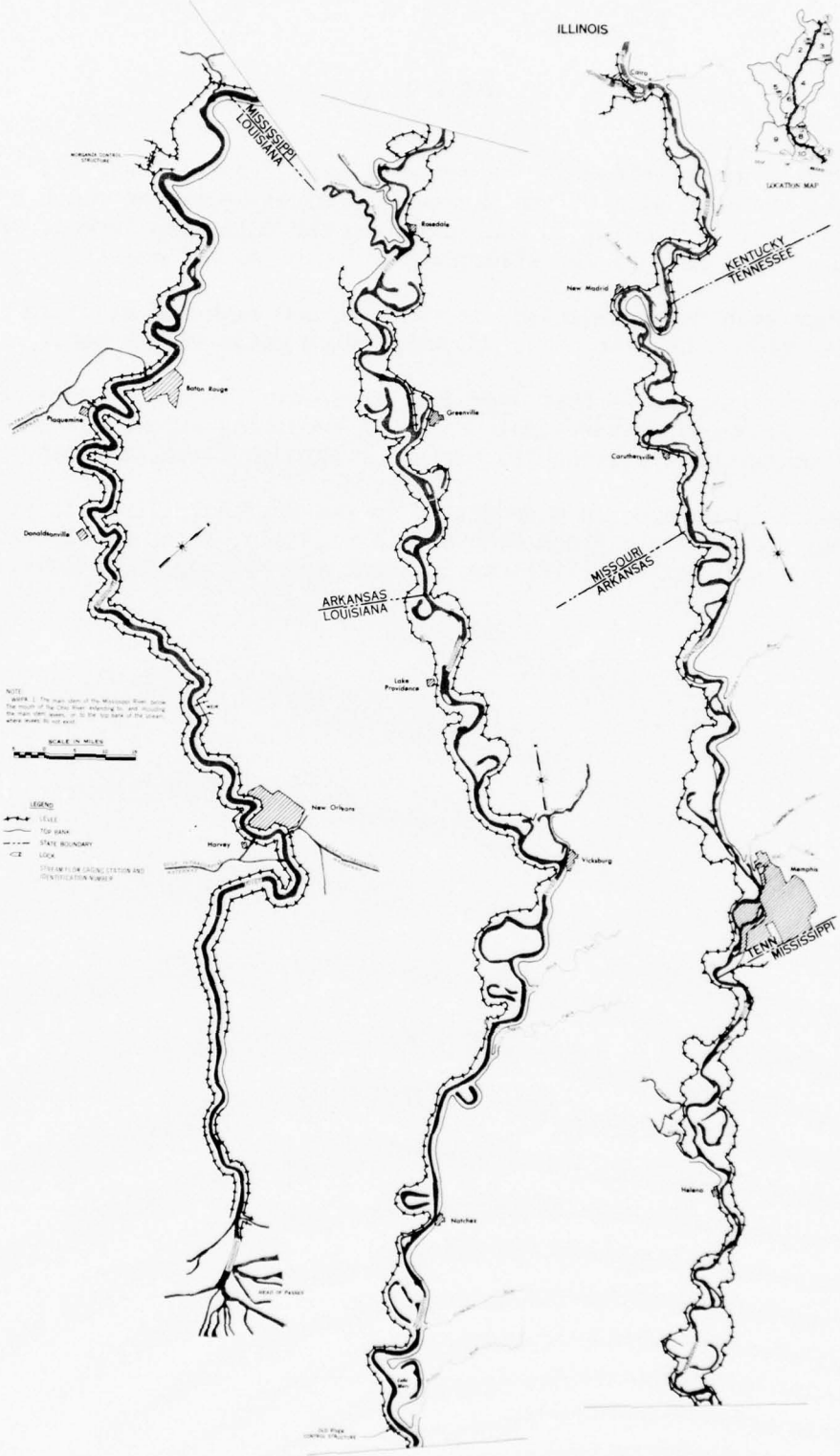


LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

WRPA 1

FIGURE 2

W R P A 2

DESCRIPTION

General

WRPA 2 comprises an area of 16,723 square miles in southeastern Missouri and eastern Arkansas (see Figure 3). The area is bounded on the east by the Mississippi River, on the north by the Castor River diversion channel and upper Castor River drainage basin and the Meramec River Basin, on the west by the White River Basin to Augusta, Ark., and extends southward downstream along the White River to the Little Red River Basin and the Arkansas River Basin to Pine Bluff, Ark., and on the south by the Arkansas River right bank levee from Pine Bluff to the Mississippi River main stem levee.

The terrain principally consists of alluvial lands bounded by the Ozark Mountains on the north and west and major rivers on the south and east. A notable exception is Crowleys Ridge, a line of hills extending from the Ozark foothills near Popular Bluff, Mo., to the Mississippi River near Helena, Ark. Elevations within the WRPA vary from 150 feet m.s.l. (mean sea level) in the south to 1,750 feet m.s.l. in the north.

The landscape consists of drained swamp lands, presenting an appearance of prairie which are extensively farmed, undrained swamp lands which are usually forested with bottomland hardwoods, rolling uplands that are managed to varying degrees for agricultural production, and forested mountains.

Climate

The climate of WRPA 2 is characterized by fairly cold winters and hot summers, with the extreme months, January and July, having mean daily temperatures of 40° F. and 80° F., respectively. The mean annual temperature of the WRPA is 60° F., with an average frost-free growing season of about 7 months. Rainfall in the area averages 50 inches annually, and combined with the temperatures of the area produces a typical subtropical climate. The Gulf of Mexico area produces some violent weather periods in the WRPA during the summer and fall. The hurricanes have traditionally lost much of their force before reaching the area, but have often produced tornadoes, high winds, and heavy rainfall within the WRPA.

Economy

Approximately 627,000 people, about 10 percent of the Lower Mississippi Region population, reside in WRPA 2. Urban population as a percent of total population was 40 percent in 1970. Major centers of urban population were the Missouri cities of Charleston (5,131) New Madrid (2,719), Sikeston (14,699), and Caruthersville (7,350), and the Arkansas cities of Jonesboro (27,050), Blytheville (24,752), Forrest City (12,521), Paragould (10,639), Stuttgart (10,477), Helena (10,415), West Helena (11,007), and Marianna (6,196). Population is projected to increase to 795,000 in 2020 under the National Income Objective and to 925,000 in 2020 under the Regional Development Objective. The population will be more urbanized in 2020, with 64 percent of the total population located in cities.

Significant economic activities in the area include agriculture, mining, manufacturing, and service industries. The major manufacturing categories are food and kindred products, primary metals, chemical and allied products, and textile mill products. The 1968 manufacturing gross product was $320 million, and is expected to increase to $3.4 billion under the National Income Objective and $4.0 billion under the Regional Development Objective by 2020.

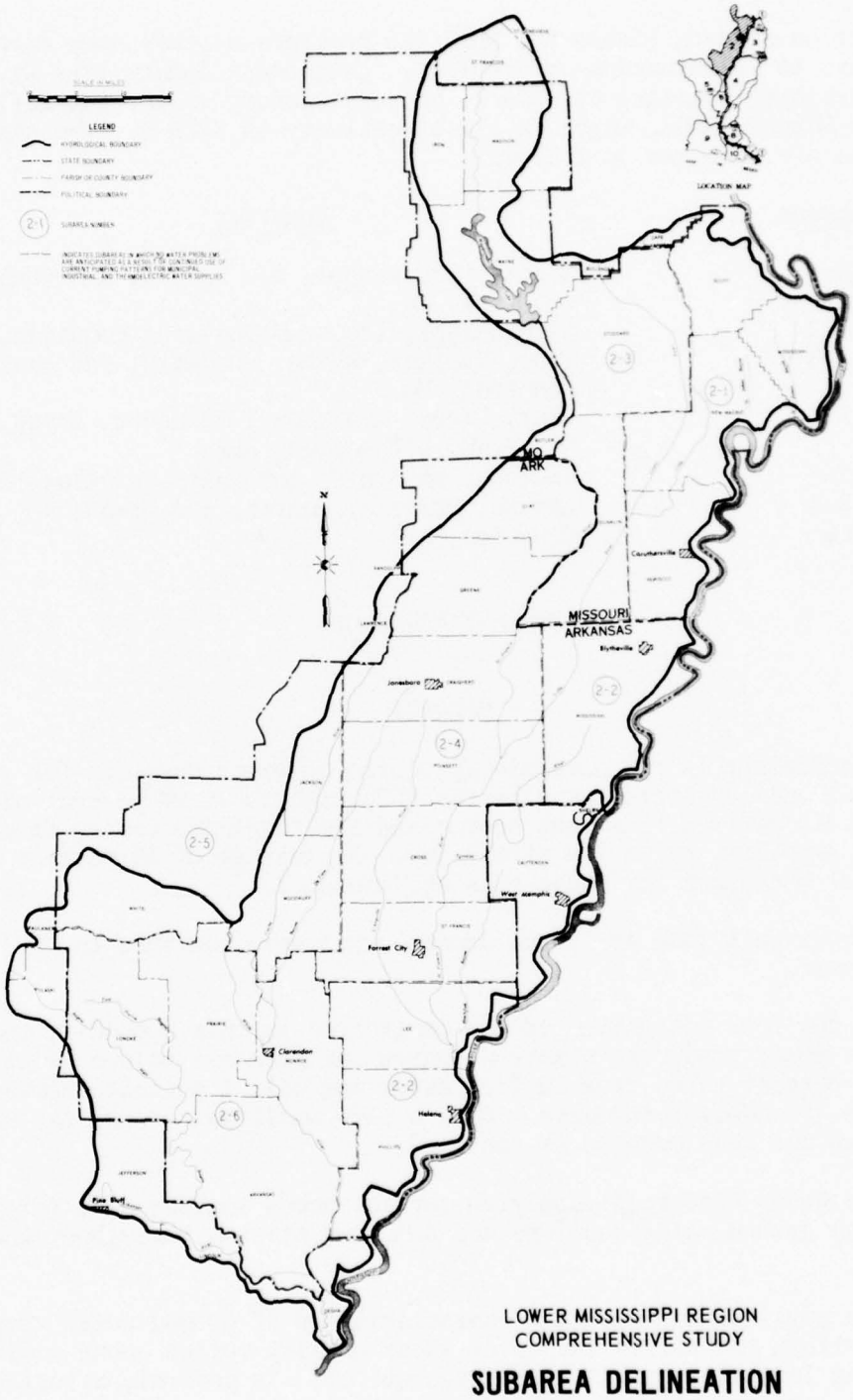
The most significant segment of the area's economy is agriculture, which includes production of soybeans, rice, corn, wheat, and cotton. In 1968, agricultural gross product was $680 million with 2020 projection being $1.03 billion under the National Income Objective and $1.10 billion under the Regional Development Objective.

Land use in the planning area, a total of 10,702,000 acres, consists of cropland, 61 percent; pasture, 7 percent; forests and woodlands, 25 percent; urban and built-up lands, 3 percent; water areas, 2 percent; and other lands, 2 percent.

Power generating plants within the WRPA include installations at Sikeston, New Madrid, and Campbell, Mo.; Helena, Jonesboro, Forrest City, and Augusta, Ark. The plant at Helena withdraws cooling water from the Mississippi River and has by far the largest capacity. The remaining plants, which produce significant amounts of electricity, also use surface water for cooling. Only those plants with relatively small capacities use ground water for cooling. The WRPA's total power needs are presently supplied from within, with surplus energy available for use outside the WRPA.

Subarea Delineation

WRPA 2 has been divided into six subareas to make data appraisal more meaningful (see Figure 3). This breakdown allows for better



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

SUBAREA DELINEATION MUNICIPAL AND INDUSTRIAL WATER SUPPLY

WRPA 2

FIGURE 3

correlation of data within the WRPA and provides a study area more conducive to illumination of problems. Crittenden County lies within the hydrologic boundary of WRPA 2, but its economy is in, and influenced by, the Memphis SMSA, which is almost entirely in WRPA 3. The six subareas are composed as follows:

Subarea	Counties
2-1	Scott, Mississippi, New Madrid, and Pemiscot Counties, Mo.
2-2	Mississippi, Lee, and Phillips Counties, Ark.
2-3	Iron, Madison, Wayne, Stoddard, and Dunklin Counties, Mo.
2-4	Clay, Green, Craighead, Poinsett, Cross, and St. Francis Counties, Ark.
2-5	Jackson, Woodruff, and White Counties, Ark.
2-6	Lonoke, Prairie, Monroe, and Arkansas Counties, Ark.

PRESENT WATER USE

General

Groundwater is the predominant source of water supplies for municipal and industrial uses in the WRPA with about 90 percent of the withdrawals derived from that source and the remainder coming from surface supplies, primarily streamflow. An average of 39 percent of the water withdrawn for these uses was consumed.

Withdrawals made for rural domestic use were confined to groundwater.

Of the four categories of use considered in this appendix, thermoelectric power producing plants withdrew the greatest volume of water with 99 percent taken from surface water and only 1 percent removed from the groundwater resource. Only a very small portion of the water withdrawn for this purpose is consumed.

The water resources supplying current needs include nine (eight artesian) ground-water aquifers and numerous streams throughout the area.

The physical and chemical characteristics of ground water vary widely within the WRPA. The exact water quality varies among aquifers and among locations within a single acquifer. In general, artesian well water is soft and slightly acidic. Shallow wells, usually in the alluvial aquifer, yield water that is relatively hard and high in iron.

Artesian aquifers usually range in depth from 100 to 1,600 feet below the surface, while wells in the alluvium range from 40 to 500 feet deep.

Physical and chemical surface water characteristics vary with location, season, and rainfall amounts. Surface water sources are generally of lower quality than ground water, however areas located in the Ozark foothills usually produce surface runoff that is of relatively high quality.

A more detailed summary of the aquifer discharge rates, thicknesses, locations, water mineral content, and surface water flow information can be found in the Regional Climatology, Hydrology and Geology Appendix.

1970 Municipal Water Use

In 1970, the average water use in WRPA 2 was about 35 million gallons per day (m.g.d.), or about 104 gallons per capita per day (GPCD). For the peak month of July, about 41 m.g.d., or about 122 GPCD, were used. About 94 percent of the total use was supplied by ground water aquifers.

Ground water is generally of good quality and suitable for most purposes. Treatment required varies with aquifer, location, and intended use, but usually consists of one or more of the following: pH adjustment, iron removal, aeration, and softening.

Surface water is generally of lower quality and usually requires more extensive treatment to obtain potable water; however, several small municipalities utilize surface water where ground water in suitable quantities is not available.

Water withdrawn in WRPA 2 for municipal use in 1970 is given in Table 11.

Table 11 - 1970 Municipal Water Use - WRPA 2[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
2-1	6.9	0.0	2.6
2-2	8.5	0.0	3.1
2-3	4.0	0.8	1.8
2-4	8.4	0.0	3.1
2-5	1.8	1.3	1.2
2-6	3.1	0.0	1.1
Total WRPA	32.7	2.1	12.9

1/ All figures are daily averages in m.g.d.

1970 Industrial Water Use

In 1970, the average water use was about 39 m.g.d., of which about 87 percent was taken from wells. Ground water is generally used when adequate supplies are available. Surface water is used in instances where other advantages offset the higher treatment costs.

Table 12 gives a subarea breakdown of industrial water use.

Table 12 - 1970 Industrial Water Use - WRPA 2[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
2-1[2/]	5.6	2.0	3.0
2-2	15.1	0.0	6.0
2-3[2/]	3.8	1.5	2.1
2-4	6.3	0.4	2.7
2-5	0.9	1.1	0.8
2-6	2.0	0.1	0.9
Total WRPA	33.7	5.1	15.5

1/ All figures are daily averages.

2/ Values are estimated.

Industries engaged in the manufacturing of chemical and allied products are located in subareas 2-2 and 2-4. These industries require relatively large amounts of water. This is reflected by water withdrawals which total over 56 percent of the WRPA's industrial water use in 1970. The remaining subareas contain numerous industries, but no major water users are evident.

1970 Thermoelectric Power Water Use

The average use of cooling water in 1970 was about 399 m.g.d., with only 2.5 m.g.d. being consumed.

Seven plants are presently in operation, with three using ground water for cooling and four drawing from surface streams. Those using ground water are relatively small and power outputs are usually consumed within the immediate area, with cooling water recirculated minimizing resource depletion. The plants using "once through" surface water cooling, withdraw from major streams including the L'Anguille, White, and Mississippi Rivers.

The quality of ground and surface water in WRPA 2 is suitable without treatment for most cooling applications.

Table 13 gives a breakdown of thermoelectric power water use.

Table 13 - 1970 Thermoelectic Power Water Use - WRPA 2[1/]

	Ground	Surface	Total
Withdrawal (m.g.d.)	5.0	394.0	399.0
Consumption (m.g.d.)	0.2	2.3	2.5
Return Flow (m.g.d.)	4.8	391.7	396.5

1/ All figures are daily averages.

1970 Rural Domestic Water Use

Approximately 309,000 people, 49 percent of the population were served by individually owned wells in 1970. This water use, classed as rural domestic use, is illustrated in Table 14. All rural domestic water is derived from ground-water sources, and is considered to be totally consumed.

Table 14 - 1970 Rural Domestic Water Use - WRPA 2[1/]

Subarea	Withdrawal		Consumption
	Ground	Surface	
2-1	3.2	0.0	3.2
2-2	3.7	0.0	3.7
2-3	4.4	0.0	4.4
2-4	4.5	0.0	4.5
2-5	4.7	0.0	4.7
2-6	4.2	0.0	4.2
Total WRPA	24.7	0.0	24.7

1/ All figures are daily averages in m.g.d.

FUTURE WATER NEEDS

General

The future municipal and industrial water needs will be determined by the area's population, per capita use rate, and industrial growth. The population, per capita use rate, and industrial production are projected to rise throughout the study period.

The municipal water needs will be increased by the continuous movement of people to municipal areas from rural areas and the installation of centrally supplied rural systems.

The production in industry is forecast to show continued strong growth. This will compound the increase in future industrial and thermoelectric power water needs.

Future Municipal Water Needs

The total WRPA 2 population is projected to increase throughout the study period and urbanization is expected to accelerate. Urban and rural residents served by public water systems will also be affected since total number and percent of people served is expected to increase. In addition, an expected higher level of affluence will tend to increase per capita consumption. These factors form the basis for quantifying municipal water use totals which are shown in Tables 15 and 16.

Table 15 - Future Municipal Water Needs - WRPA 2[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2-1	7.9	2.9	11.2	4.2	16.3	6.1
2-2	9.8	3.6	13.9	5.2	20.2	7.5
2-3	5.5	2.0	7.8	2.9	11.3	4.2
2-4	9.7	3.6	13.7	5.1	20.0	7.5
2-5	3.6	1.3	5.0	1.9	7.4	2.8
2-6	3.6	1.3	5.0	1.9	7.4	2.8
Total WRPA	40.1	14.7	56.6	21.2	82.6	30.9

1/ A-1 figures are daily averages in m.g.d.

Table 16 - Future Municipal Water Needs - WRPA 2[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2-1	8.5	3.1	12.6	4.7	18.9	7.1
2-2	10.5	3.9	15.6	5.8	23.5	8.8
2-3	5.9	2.2	8.7	3.2	13.2	4.9
2-4	10.4	3.8	15.3	5.7	23.3	8.7
2-5	3.9	1.4	5.6	2.1	8.6	3.2
2-6	3.9	1.4	5.6	2.1	8.6	3.2
Total WRPA	43.1	15.8	63.4	23.6	96.1	35.9

1/ All figures are daily averages in m.g.d.

Future Industrial Water Needs

The projected population growth, combined with continued exports are expected to increase the demand for goods and services sufficiently to stimulate industrial growth. The amount of water required is dependent on the volume of production and the processes used. The total production is expected to increase as is the efficiency of the production processes utilized. The resulting values for industrial water use are shown in Tables 17 and 18.

Table 17 - Future Industrial Water Needs - WRPA 2[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2-1	11.7	4.7	29.1	11.6	68.1	27.2
2-2	22.2	8.9	53.1	21.3	122.1	48.9
2-3	8.1	3.3	20.2	8.1	47.6	19.0
2-4	10.2	4.1	25.4	10.2	59.5	23.8
2-5	2.9	1.2	7.2	2.9	16.6	6.7
2-6	3.2	1.3	7.8	3.1	18.1	7.3
Total WRPA	58.3	23.5	142.8	57.2	332.0	132.9

1/ All figures are daily averages in m.g.d.

Table 18 - Future Industrial Water Needs - WRPA 2[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
2-1	12.9	5.1	33.5	13.4	80.2	32.1
2-2	24.3	9.7	61.3	24.5	143.9	57.6
2-3	8.9	3.6	23.4	9.3	56.0	22.4
2-4	11.2	4.5	29.3	11.7	70.1	28.0
2-5	3.2	1.3	8.3	3.3	19.6	7.8
2-6	3.5	1.4	9.0	3.6	21.4	8.5
Total WRPA	64.0	25.6	164.8	65.8	391.2	156.4

1/ All figures are daily averages in m.g.d.

Future Thermoelectric Power Water Needs

Expected power production by existing and new plants within WRPA 2 will continue to produce surplus energy through 1980. Future power water needs are shown in Table 19.

Future Rural Domestic Water Needs

Rural domestic water needs, supplied primarily by individually owned wells, are expected to decline in future years due to wider use of community systems, as well as a decline in rural population. Future rural domestic water needs are summarized in Table 20.

Table 19 - Future Thermoelectric Power Water Needs - WRPA 2[1/]

	1980		2000		2020	
	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Withdrawal	399.0	399.0	641.5	718.5	766.4	889.1
Consumption	2.5	2.5	7.7	8.6	12.1	14.0
Return Flow	396.5	396.5	633.8	709.9	754.3	875.1

1/ All figures are daily averages in m.g.d.

Table 20 - Future Rural Domestic Water Needs - WRPA 2[1/]

	1980		2000		2020	
Subarea	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
2-1	2.7	2.9	2.1	2.3	1.4	1.6
2-2	3.1	3.4	2.4	2.7	1.6	1.8
2-3	3.7	4.0	2.9	3.2	1.9	2.2
2-4	3.7	4.0	2.9	3.2	1.9	2.2
2-5	3.9	4.2	3.0	3.3	2.0	2.3
2-6	3.5	3.8	2.7	3.0	1.8	2.1
Total WRPA	20.6	22.3	16.0	17.7	10.6	12.2

1/ All figures are daily average withdrawals in m.g.d. Consumption assumed equal to withdrawals.

SUMMARY OF WATER NEEDS

Municipal water is generally taken from ground-water sources, but several small towns use surface water in areas where ground water is not adequate or where other advantages can be realized. No major municipal water shortages have been identified and none are expected to occur during the study period.

Projected industrial water needs can be supplied by ground water, but some industries use surface sources and are expected to continue. Major industrial water shortages probably will not occur within the study period.

Cooling water use for thermoelectric generating plants will continue to increase, but new installations and existing plant additions are expected to withdraw from the Mississippi and White Rivers. Plants presently using ground water are not expected to expand significantly and will ultimately be phased out. Consequently, no shortages can be foreseen within the study period.

Population served by rural domestic systems will continue to decline, consequently, future use will decrease for each successive time period considered.

Future requirements for purposes other than municipal, industrial, rural domestic, and thermoelectric cooling are considered in other appendixes. Discussion of water shortages anticipated when considering all water needs can be found in the Plan Formulation Appendix.

Table 21 shows a summary of water needs for WRPA 2.

Table 21 - Summary of Water Needs - WRPA 2[1/]

Use	1970	1980		2000		2020	
		National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Rural Domestic	24.7	20.6	22.3	16.0	17.4	10.6	12.2
Municipal	34.8	40.1	43.1	56.6	63.4	82.6	96.1
Industrial	38.8	58.3	64.0	142.8	164.8	332.0	391.2
Thermoelectric	399.0	399.0	399.0	641.5	718.5	766.4	889.1
Total WRPA	497.3	518.0	528.4	856.9	964.1	1,191.6	1,388.6

[1/] All figures are daily average withdrawals in m.g.d.

W R P A 3

DESCRIPTION

General

WRPA 3 comprises a total area of 11,260 square miles located in portions of four States, western Kentucky, western Tennessee, and northern Mississippi. The area is bounded on the west by the Mississippi River, on the north and east by a line which separates the drainage areas of the Ohio and Tennessee Rivers from the Mississippi River, and on the south by a line which separates the drainage areas of Nońconnah Creek and Hatchie River from the Coldwater and Little Tallahatchie Rivers (see Figure 4). The economic boundary of the area includes Crittenden County, Arkansas (part of the Memphis SMSA), which by hydrologic definition is within WRPA 2, and excludes the flood protected area at Cairo, Illinois. The general topography may be divided into two sections separated by the loessal bluffs that parallel the Mississippi River. To the west lies the alluvium of the Mississippi-Ohio complex which has a maximum width of about 20 miles. To the east the land form consists of rolling uplands with gentle relief dissected by numerous streams in the area. Elevations vary from 200 feet mean sea level (m.s.l.) in the alluvium to 580 m.s.l. in the hills of west Tennessee and Kentucky.

Climate

The climate, characterized by fairly cold winters and hot summers, generally consists of about 50 inches annual rainfall combined with a mean annual temperature of 60° F. Temperature extremes generally occur in January and July, which have respective mean temperatures of 40° F. and 80° F. The average frost-free growing period is about 7 months. Tropical storms coming from the Gulf of Mexico sometimes produce periods of heavy rainfall, but the hurricane-force storms tend to lose their destructive capabilities before reaching the area.

Economy

Approximately 1,258,000 people, about 20 percent of the region's population, reside within the WRPA. Urban population in 1970 was 70 percent of the WRPA total and is projected to be 88 percent in 2020. Major population centers with 1970 census figures shown include Mayfield, Ky., (10,948), Corinth, Miss., (11,581), and the Tennessee cities of Memphis (SMSA 767,050), Jackson (39,262, Dyersburg (13,942) and Union

City (9,504). Population in 2020 is projected to be 2,569,000 under the National Income Objective and 2,983,000 under the Regional Development Objective.

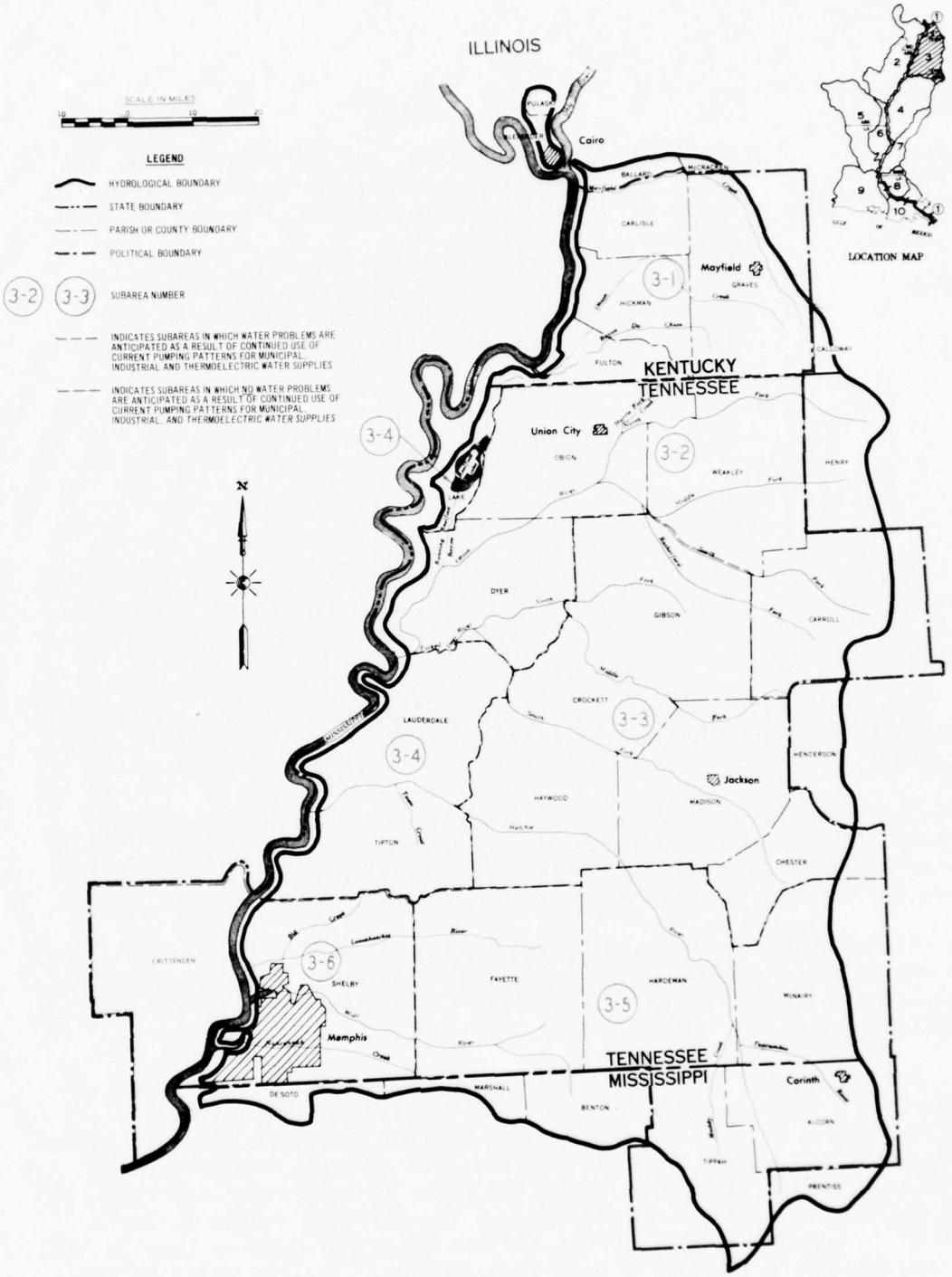
Significant economic activities in the area include agriculture, manufacturing, and service industries. The major manufacturing categories are food and kindred products, chemical and allied products, paper and allied products, and textile mill products. The 1968 manufacturing gross product was approximately $1.2 billion, and by 2020 is expected to increase to $12.1 billion under the National Income Objective and $14.4 billion under the Regional Development Objective. In 1968, the agricultural gross product was $322 million, or the third largest WRPA total in the region. The projected gross product for agricultural output in 2020 is $546 million under the National Income Objective and $591 million under the Regional Development Objective. Major crops include cotton, soybeans, grain, and hay.

The total surface area within the WRPA is 6,818,000 acres with land use presently distributed among cropland (43 percent), pasture (14 percent), forests and woodlands (34 percent), urban and built-up lands (5 percent), water areas (1 percent), and other lands (3 percent).

The Thomas H. Allen thermoelectric power generating plant, located near Memphis, and the only power generating plant in WRPA 3, withdraws cooling water from the Mississippi River. About 50 percent of the area's total power needs in 1970 were supplied by this plant, which is operated by the Tennessee Valley Authority. Remaining needs are generally met by sources outside the area and region by a network of TVA power generating plants.

Subarea Delineation

WRPA 3 has divided into six subareas to make data appraisal more meaningful. This breakdown is based on the smaller hydrologic drainage basins within the WRPA modified to conform to county boundaries (see Figure 4). This breakdown allows a better correlation of data within the WRPA and provides a study area more conducive to illumination of specific problems. The six subareas are composed as follows:



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

SUBAREA DELINEATION MUNICIPAL AND INDUSTRIAL WATER SUPPLY

WRPA 3

FIGURE 4

Subarea	County
3-1	Carlisle, Hickman, Fulton, and Graves Counties, Ky.
3-2	Dyer, Obion, Weakley, and Carroll Counties, Tenn.
3-3	Crockett, Haywood, Gibson, Madison, Chester Counties, Tenn.
3-4	Tipton, Lauderdale, and Lake Counties, Tenn.
3-5	Fayette, Hardeman, and McNairy Counties, Tenn.; Alcorn and Tippah Counties, Miss.
3-6	Memphis SMSA - Shelby County, Tenn. and Crittenden County, Ark.

PRESENT WATER USE

General

Most municipal and industrial water withdrawals in WRPA 3 are made from ground water with only about 2 percent derived from surface water sources. An average of about 28 percent of water withdrawals for these uses is consumed.

Rural domestic supplies are obtained from ground water exclusively, and all the water withdrawn for this category of use is assumed to be consumed.

Thermoelectric power production within the WRPA accounts for 63 percent of the total water withdrawals for the four categories of use considered in this appendix. Only a very small portion of water withdrawn for cooling purposes is consumed, however.

Ground water is supplied by six aquifers, five of the artesian type and one of the unconfined type, which underlay various portions of the WRPA. The extent to which each aquifer is developed depends on location, required yields, and water quality.

The quality of water received from each aquifer depends on the minerals and organic matter present in the material comprising the aquifer. As a result, the exact water quality varies among aquifers and among locations within a single aquifer. In general, however, the artesian aquifers yield soft water and range in depth from less than 100 feet to 1,600 feet below the surface. The alluvium ranges in depth from 40 to approximately 200 feet and its wells yield water that is hard, acidic, and has a relatively high iron content. Shallow wells in the artesian aquifers also tend to produce acidic water which can cause problems if not treated.

Surface water quality varies throughout the WRPA and is generally of poorer quality than the ground water.

A more detailed summary of the aquifer discharge rates, thicknesses, locations, water-mineral content, and surface-water flow information can be found in the Regional Climatalogy, Hydrology and Geology Appendix.

1970 Municipal Water Use

In 1970 the average municipal water use was about 142 m.g.d., with July, the peak month, requiring about 150 m.g.d. This represented a daily gallons per capita use of 133 and 143, respectively. All was supplied by ground-water aquifers.

Ground water is generally of good quality and suitable for most purposes. Treatment required varies with aquifer, location, and intended use, but usually consists of one or more of the following: pH adjustment, iron removal, aeriation, and softening. Since ground water is plentiful and of good quality, no municipal use is made of the surface water resource.

Surface water is generally of lower quality and requires more extensive treatment to obtain potable water.

Table 22 gives a subarea breakdown of use.

Table 22 - 1970 Municipal Water Use - WRPA 3[1/]

Subarea	Withdrawal		Total Consumption
	Ground water	Surface water	
3-1	4.0	0.0	1.5
3-2	10.2	0.0	3.8
3-3	9.3	0.0	3.5
3-4	2.5	0.0	1.0
3-5	5.7	0.0	2.0
3-6 (SMSA)	110.1	0.0	40.9
Total WRPA	141.8	0.0	52.7

1/ All figures are daily averages in m.g.d.

1970 Industrial Water Use

In 1970 the average use was about 98 m.g.d., of which about 96 percent was taken from ground water sources.

Quality of ground water is acceptable with minimal treatment for most industrial purposes, and surface water is used only when relatively low quality can be tolerated.

Table 23 gives a subarea breakdown of use.

Table 23 - 1970 Industrial Water Use - WRPA 3[1/]

Subarea	Withdrawal		Total Consumption
	Ground water	Surface water	
3-1	4.5	0.0	0.7
3-2	11.0	0.0	0.4
3-3	7.0	0.0	1.8
3-4	1.6	0.0	0.1
3-5	10.2	0.0	1.2
3-6 (SMSA)	60.3	3.5	10.4
Total WRPA	94.6	3.5	14.6

1/ All figures are daily averages in m.g.d.

Subareas 3-3, 3-5, and 3-6 have industries which require relatively large amounts of water in their activities, which include the manufacturing of chemical and paper products and processing of food and kindred products. About 85 percent of the WRPA's total water use in 1970 is attributed to these three subareas.

The high level of industrial development in the Memphis SMSA (subarea 3-6) is reflected by withdrawals which are nearly double the combined withdrawals of all other subareas in the WRPA.

1970 Thermoelectric Power Water Use

The average use of cooling water in 1970 was about 430 m.g.d. (with 6 m.g.d. being consumed) by a single plant located near Memphis. All was taken from the Mississippi River and utilized in a "once-through" system.

All ground and most surface waters in WRPA 3 are of acceptable quality requiring no treatment prior to cooling use.

Table 24 gives a breakdown of use.

Table 24 - 1970 Thermoelectric Power Water Use - WRPA 3[1/]

	Ground	Surface
Withdrawal	0.0	430.0
Consumption	0.0	6.0
Return Flow	0.0	424.0

1/ All figures are daily averages in m.g.d.

1970 Rural Domestic Water Use

In WRPA 3, approximately 241,000 people, or 19 percent of the 1970 population, were served by individually owned wells and not by any municipal water system. This water use is classed as rural domestic use and, as illustrated in Table 25, all rural domestic water is derived from ground water sources, and is considered to be totally consumed.

Table 25 - 1970 Rural Domestic Water Use - WRPA 3[1/]

Subarea	Withdrawal		Consumption
	Ground	Surface	
3-1	2.7	0.0	2.7
3-2	3.9	0.0	3.9
3-3	3.1	0.0	3.1
3-4	4.2	0.0	4.2
3-5	5.4	0.0	5.4
3-6 (SMSA)	0.0	0.0	0.0
Total WRPA	19.3	0.0	19.3

1/ All figures are daily averages in m.g.d.

FUTURE WATER NEEDS

General

The future municipal and industrial water needs for this area will be determined by the area's population, industrial growth, and per capita use rate. The population, employment, and per capita use rate of the WRPA are projected to rise throughout the study period.

The municipal water needs will be increased by the continuous movement of people to municipal areas from rural areas and the installation of centrally supplied rural water systems.

The industrial production is forecast to show continuous strong growth and will compound the increase in the future industrial water needs.

Future Municipal Water Needs

The total WRPA 3 population is projected to increase throughout the study period and urbanization is expected to accelerate. Urban and rural residents served by public water systems will also be affected since total number and percent of people served both increase. In addition, an expected higher level of affluence will tend to increase per capita consumption. These factors form the basis for quantifying municipal water needs totals as shown in Tables 26 and 27.

The Memphis SMSA accounts for about 82 percent of the WRPA's municipal withdrawals in 1970, and a decrease to about 72 percent is expected under the Regional Development Objective in 2020. This is indicative of a slower urbanization trend in the SMSA, while urbanization as a whole is expected to accelerate.

Table 26 - Future Municipal Water Needs - WRPA 3[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
3-1	5.8	2.1	10.2	3.8	14.5	5.4
3-2	14.4	5.3	28.0	10.4	46.7	17.3
3-3	11.9	4.4	22.8	8.5	32.6	12.2
3-4	3.3	1.2	6.5	2.4	12.0	4.5
3-5	8.0	2.9	15.6	5.7	29.4	10.8
3-6	132.3	48.7	195.0	72.5	273.6	102.1
Total WRPA	175.7	64.6	278.1	103.3	408.8	152.3

1/ All figures are daily averages in m.g.d.

Table 27 - Future Municipal Water Needs - WRPA 3[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
3-1	6.3	2.3	11.6	4.3	16.9	6.3
3-2	15.9	5.9	31.7	11.8	54.2	20.2
3-3	13.0	4.8	25.9	9.6	37.8	14.1
3-4	3.6	1.3	7.3	2.7	13.9	5.2
3-5	8.8	3.2	17.8	6.6	34.0	12.5
3-6	145.3	53.5	221.7	82.5	317.7	118.5
Total WRPA	192.9	71.0	316.0	117.5	474.5	176.8

1/ All figures are daily averages in m.g.d.

Future Industrial Water Needs

The demand for goods and services is expected to stimulate industrial growth. The amount of water required is dependent on both the volume of production and the processes utilized in any category of industry. The total production is expected to increase as is the efficiency of the industrial processes used. The resulting values for industrial water use are shown in Tables 28 and 29.

Table 28 - Future Industrial Water Needs - WRPA 3[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
3-1	6.7	1.0	16.0	2.4	36.4	5.5
3-2	16.7	0.7	39.3	1.6	88.9	3.6
3-3	10.6	2.8	25.0	6.5	57.0	14.8
3-4	2.4	0.2	5.8	0.5	13.3	1.1
3-5	15.4	1.9	36.6	4.4	83.4	10.0
3-6	97.7	15.6	228.5	36.6	521.6	83.5
Total WRPA	149.5	22.2	351.2	52.0	800.6	118.5

1/ All figures are daily averages in m.g.d.

Table 29 - Future Industrial Water Needs - WRPA 3[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
3-1	7.4	1.1	18.5	2.8	43.0	6.4
3-2	18.3	0.7	45.5	1.8	104.8	4.2
3-3	11.6	3.0	28.6	7.4	67.2	17.5
3-4	2.6	0.2	6.6	0.5	15.7	1.3
3-5	16.9	2.0	41.9	5.0	98.3	11.8
3-6	107.0	17.1	257.0	41.1	615.2	98.4
Total WRPA	163.8	24.1	398.1	58.6	944.2	139.6

1/ All figures are daily averages in m.g.d.

Future Thermoelectric Power Water Needs

As mentioned earlier in the text, there is only one thermoelectric power plant in WRPA 3, the Thomas H. Allen Plant in Memphis, and much of the energy needs are supplied by sources outside the WRPA.

Expected power production within WRPA 3 will continue to fall short of the needs through 1980. However, after 1980, production of new plants will begin to "catch up" and by 2020 all power needs can be satisfied by plants located within the WRPA. Future power needs are translated into water needs by applying a water-use factor to future WRPA power-production estimates.

Table 30 gives projected requirements.

Future Rural Domestic Water Needs

Rural domestic water needs are primarily supplied by individually owned wells. The population served by this type of system is expected to decrease in future years due to wider use of community water systems and a decline of rural population. Future rural domestic water needs are summarized in Table 31.

Table 30 - Future Thermoelectric Power Water Needs - WRPA 3[1/]

	1980		2000		2020	
	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Withdrawal	549.9	633.6	1,565.6	1,780.0	1,981.6	2,300.5
Consumption	8.9	9.9	18.7	21.2	31.3	36.3
Return Flow	541.0	623.7	1,546.9	1,758.8	1,950.3	2,264.2

1/ All figures are daily averages in m.g.d.

Table 31 - Future Rural Domestic Water Needs - WRPA 3[1/]

	1980		2000		2020	
Subarea	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
3-1	2.8	3.1	2.0	2.3	1.7	2.0
3-2	4.0	4.4	2.9	3.3	2.4	2.8
3-3	3.2	3.5	2.3	2.6	1.9	2.2
3-4	4.4	4.8	3.1	3.5	2.6	3.0
3-5	5.6	6.2	4.0	4.5	3.3	3.9
3-6	0	0	0	0	0	0
Total WRPA	20.0	22.0	14.3	16.2	11.9	13.9

1/ All figures are daily average withdrawals in m.g.d; consumption assumed equal to withdrawals.

SUMMARY OF WATER NEEDS

Municipal systems presently utilize ground-water supplies exclusively. Ground water is generally of good quality, and supply is adequate to meet projected needs throughout the study period.

Future industrial use is projected to exceed available ground-water supplies not committed to municipal use in subareas 3-5, and 3-6 by 2020, and alternate sources of supply will be required, if the projected use is realized.

Thermoelectric cooling-water withdrawal needs are significant quantities, but consumption is almost negligible. The present source of supply for cooling water in WRPA 3 is the Mississippi River, and projections indicate future plants will continue to withdraw from the Mississippi, consequently, no supply problems are anticipated.

Population served by rural domestic systems will continue to decline, consequently, future needs will be reduced for each successive time period considered.

Future requirements for purposes other than municipal, industrial, rural domestic, and thermoelectric cooling are considered in other appendixes. Discussion of water shortages anticipated when considering all water needs can be found in the Plan Formulation Appendix.

Table 32 shows a summary of water needs for WRPA 3.

Table 32 - Summary of Water Needs - WRPA 3[1/]

Use	1970	1980		2000		2020	
		National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Rural Domestic	19.3	20.0	22.0	14.3	16.2	11.9	13.9
Municipal	141.8	175.7	192.9	260.0	316.0	408.8	474.5
Industrial	98.1	149.5	163.8	351.2	398.1	800.6	944.2
Thermoelectric	430.0	549.9	633.6	1,565.6	1,780.0	1,981.6	2,300.5
Total WRPA	689.2	895.1	1,012.3	2,209.2	2,510.3	3,202.9	3,733.1

[1/] All figures are daily average withdrawals in m.g.d.

W R P A 4

DESCRIPTION

General

WRPA 4 lies in the northwest section of the State of Mississippi and contains the drainage basin of the Yazoo River and its tributaries. Main tributaries include the Tallahatchie, Yalobusha, and Big Sunflower Rivers. Four flood control reservoirs are located in the upper hill section of the WRPA. The hydrologic boundary of the WRPA is formed by the east bank Mississippi River levee to the west and by the divides of the Wolf and Hatchie River Basins to the north. The divides of the Tombigbee and Big Black River Basins form the eastern and southern hydrologic boundaries, respectively. The western half of the WRPA lies in the alluvial valley of the Mississippi River, and the eastern half is comprised of rolling to rugged hills. The total drainage area of the WRPA is 13,355 square miles and occupies all or part of 30 countries.

Climate

The climate of the WRPA is generally mild. Summers are long, hot, and humid, and winters are short and moderate. During winter months the prevailing winds are from the north and northwest. During other seasons, prevailing winds are from the south and southwest. The average annual temperature is 64° F., and average monthly temperatures vary from 47° F. in January to 82° F. in July. Observed extremes in the area range from 115° F. To minus 16° F. The average annual rainfall for the WRPA is 52 inches, and the average monthly rainfalls vary from a low of 2.5 inches in October to a high of 6 inches in January.

Economy

The population of the WRPA in 1970 was approximately 638,000, about 10 percent of the total population for the Lower Mississippi Region. Fifty-seven percent of the population of the WRPA was serviced by some form of central water system while 43 percent was not. Municipal water systems serviced 237 communities, varying in size from 33 people in Cobb, Miss., to almost 40,000 people in Greenville, Miss. Of the 237 communities, 42 had populations over 2,500 and four had populations of over 20,000, Greenville, Vicksburg, Greenwood, and Clarksdale. The total population of the WRPA is projected to be

828,000 or 941,000 by the year 2020, depending on whether the National Income or Regional Development Ovjective is realized.

The economy of the area is based primarily on agricultural activities, but manufacturing and other industries also make considerable contributions. In 1968, production of the manufacturing industries was valued at $330.7 million and is projected to go as high as $4.2 billion by 2020 if the Regional Development Objective is reached. In 1968, 231,000 people were employed and had earnings of $973.7 million within the WRPA. Of these total earnings, manufacturing industries accounted for 21 percent.

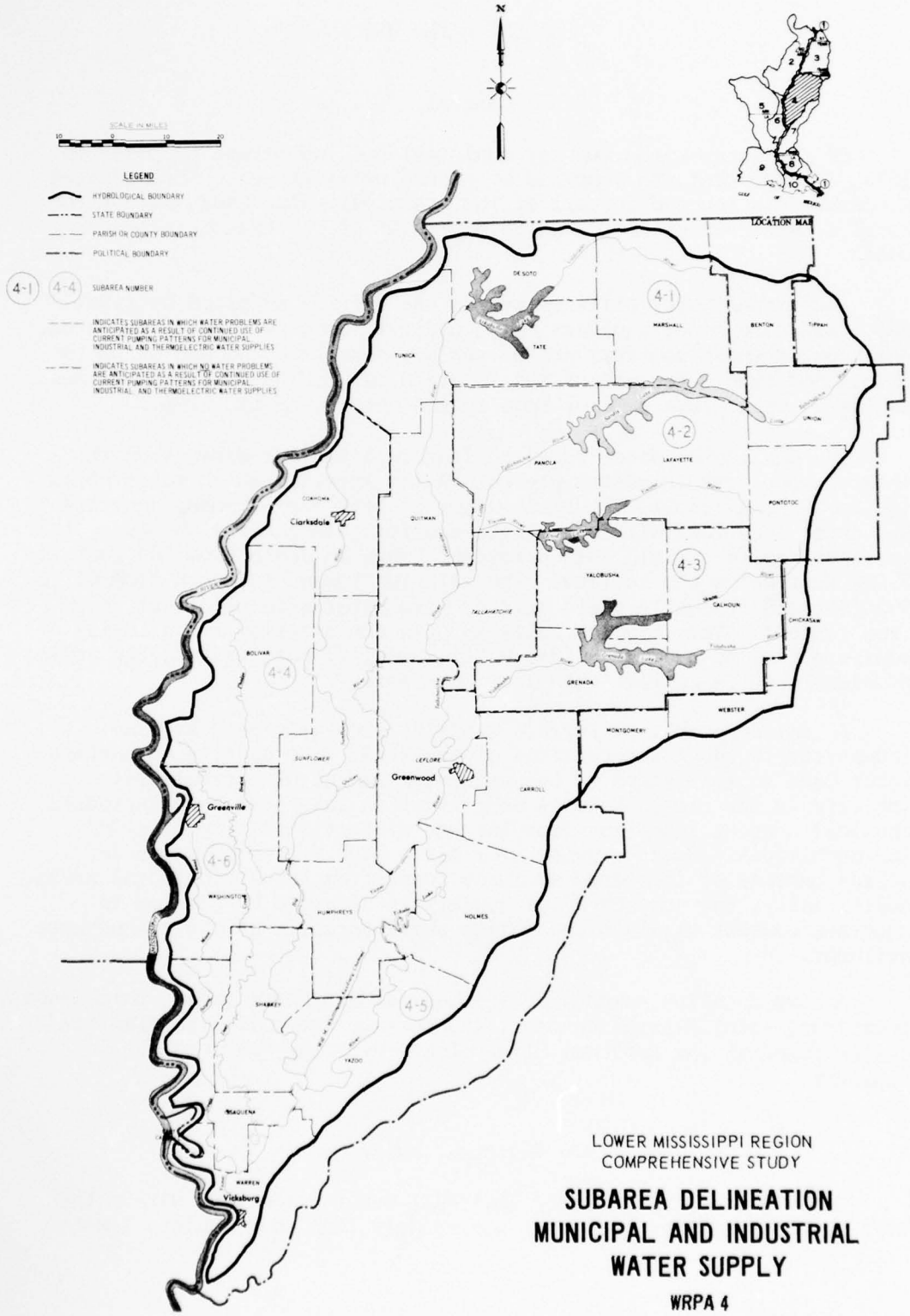
There are several important water-using manufacturing industries within the WRPA. Their production of the primary and allied goods of the food, paper, chemical, and petroleum industries requires ample quantities of water having acceptable quality.

The economy of the area is influenced by the presence of adequate power sources. There are seven thermoelecric generation plants within the WRPA. Although some of the electric power needs of the area are met by plants located outside the WRPA, 1970 data show that thermoelectric plants within the study area generated enough power to satisfy all the area's power requirements, as well as provide surplus power to other areas through the interconnected systems of the Southwest Power Pool members.

Subarea Delineation

WRPA 4 has been divided into six subareas to make data appraisal more meaningful. This breakdown is selected to approximate the individual drainage sub-basins within the WRPA and then modified to conform to county boundaries (see Figure 5). This breakdown allows for better correlation of data within the WRPA and provides small enough study areas to illuminate problem areas. WRPA 4, when modified to conform to county boundaries, occupies 26 complete counties. The hydrologic area excluded by this modification is comprised of small portions of Tippah, Chickasaw, Montgomery, and Webster Counties in Mississippi. The six modified subareas are composed as follows:

Subarea	Counties
4-1	Desoto, Marshall, Tunica, Tate, Quitman
4-2	Benton, Union, Pontotoc, Lafayette, Panola, Tallahatchie
4-3	Calhoun, Yalobusha, Grenada
4-4	Coahoma, Bolivar, Sunflower, Humphreys
4-5	Leflore, Carroll, Holmes, Yazoo, Issaquena, Warren, Sharkey
4-6	Washington



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

SUBAREA DELINEATION MUNICIPAL AND INDUSTRIAL WATER SUPPLY

WRPA 4

FIGURE 5

PRESENT WATER USE

General

Of the water withdrawn for municipal and industrial purposes in 1970, 73.3 percent was supplied by ground water sources. Groundwater withdrawals accounted for all of the municipal water used, all of the rural domestic water used, and 56.6 percent of the industrial water used.

The ground water utilized within the WRPA is supplied by five major and nine minor aquifers which underlay some portion of the area. Thirteen of those aquifers are of the artesian type and one is of the unconfined type. Because of the location and characteristics of these aquifers, each plays a major role in its portion of the WRPA.

The quality of water received from each aquifer depends on the minerals and organic matter present in the material which makes up the aquifer. As a result, the exact water quality varies among aquifers and among locations within a single aquifer. In general, however, the artesian aquifers yield soft water and range in depth from 200 feet to 3,500 feet below the surface. The alluvium ranges in depth from 40 to 500 feet and its wells yield acidic, hard water with relatively high iron content. Very shallow wells in both the artesian and alluvial aquifers tend to produce acidic water which, if not treated, can cause problems when in contact with iron metalwork.

A limited amount of surface water is presently used by some industries in the lower portions of the WRPA. The quality of surface water used is influenced by the extensive amount of agricultural activity in the area. Streams and rivers in this area have increased chemical content resulting from the use of fertilizers, pesticides, and herbicides. Surface water also has a high degree of suspended solids because of increased sediment loads from the agricultural areas. Additionally, the surface water quality is affected by the low to moderate content of dissolved solids characteristic of the ground water effluent.

A more detailed summary of the aquifer discharge rates, thicknesses, locations, water mineral content, and surface water flow information can be found in the Regional Climatology, Hydrology and Geology Appendix.

1970 Municipal Water Use

In 1970 the average daily municipal water withdrawal within the WRPA was 53.8 million gallons. During July, the peak municipal water

use month in 1970, the average daily use was 60.2 million gallons. All of this water was supplied from ground water sources. This withdrawal of 52.8 m.g.d. reflected a 147 GPCD use in areas serviced by central water systems, as compared to the national average of 166 GPCD.

Withdrawal requirements far exceed actual comsumptive use. This is reflected in data collected nationwide indicating that 63 percent of water withdrawn for municipal use is returned to a stream and made available for re-use.

Municipal water pumpages by county and major users are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use. Table 33 gives a breakdown, by subarea, of the 1970 municipal water withdrawals.

Table 33 - 1970 Municipal Water Use - WRPA 4[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
4-1	4.9	0.0	1.8
4-2	6.5	0.0	2.4
4-3	3.9	0.0	1.5
4-4	9.9	0.0	3.7
4-5	20.6	0.0	7.6
4-6	8.0	0.0	3.0
Total WRPA	53.8	0.0	20.0

1/ All figures are daily averages in m.g.d.

As previously mentioned, the ground water quality within the WRPA varies according to the type aquifer, the aquifer composition, and the location of the well in the aquifer. The quality of the raw intake water governs the degree of treatment required. Accordingly, the method of treatment varies widely throughout the WRPA. Treatment varies from a simple chlorination process in some communities to elaborate systems of chlorination, aeration, filtration, fluoridation, and pH correction in others.

In all cases, the actual amount of treatment performed is dependent on the quality of raw water and the ability or willingness of the users to pay for its treatment.

1970 Industrial Water Use

Industrial activity within WRPA 4 during 1970 required a daily average water withdrawal of 86.6 m.g.d. Ground water supplied 56.7 percent of this withdrawal and surface sources supplied 43.3 percent.

Industrial water pumpages by subarea are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use. Table 34 gives a breakdown by subarea of the 1970 industrial water withdrawals.

Table 34 - 1970 Industrial Water Use - WRPA 4[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
4-1	9.5	0.0	3.5
4-2	1.6	0.0	0.9
4-3	2.3	0.0	0.7
4-4	6.0	0.0	0.5
4-5	17.7	37.5	1.1
4-6	12.0	0.0	0.4
Total WRPA	49.1	37.5	7.1

[1/] All figures are daily averages in m.g.d.

In subarea 4-1, the industries utilizing the bulk of the 9.5 m.g.d. produce finished food products, petroleum derivative products, chemicals, and fertilizers. Subareas 4-2, 4-3, and 4-4 have several types of industries, but no individual large water users. Subarea 4-5 uses 55.2 m.g.d. in its food processing industries; chemical, paper, and fertilizer producing industries; and in the production of lumber and wood products. In subarea 4-6, 12.0 m.g.d. is withdrawn for use in the food processing industries, metal products fabrication, and fiber board and chemical production. Because the industries in WRPA 4 produce a wide variety of goods, each industry has its own water quality requirements and subsequent treatment. The degree of treatment ranges from no treatment in industries using water as a cooling agent for bearings or condensers to a full five-step system of treatment in some food producing industries. These systems were previously mentioned under 1970 Municipal Water Use.

The quality of the raw intake water and its intended use will govern the type of treatment required for the various industrial processes.

1970 Thermoelectric Power Water Use

Because of the large volume of water required to cool condensers in thermoelectric units, all plants in WRPA 4 either use surface water for cooling purposes or use ground water recirculated through cooling towers. The seven thermoelectric plants in WRPA 4 are located at Vicksburg, Yazoo City, Greenwood (2), Clarksdale (2), and Cleveland. A new plant is currently under construction in Greenville, Miss., which is expected to go on line in 1973. These seven existing plants are currently producing enough power to meet the electric power requirement for the WRPA and supply surplus power to the interconnected systems of the Southwest Power Pool members. More information on this system is available in the Power Appendix. Table 35 indicates the 1970 thermoelectric water use for WRPA 4.

Table 35 - 1970 Thermoelectric Power Water Use - WRPA 4[1/]

	Ground	Surface	Total
Withdrawal	31.1	273.9	305.0
Consumption	0.3	2.4	2.7
Return Flow	30.8	271.5	302.3

1/ All figures are daily averages in m.g.d.

Of the seven thermoelectric plants within the WRPA, five utilize ground water and two surface water. The plants which use ground water are smaller and generally produce power for their immediate area, i.e., the city or county in which they are located. In some instances, the water used by these plants is derived from the municipal water systems. The two plants using surface water are large compared to the plants using ground water and supply power over a greater area, including portions of other States. The water used by these plants is withdrawn from the Mississippi (WRPA 1) and Sunflower Rivers.

1970 Rural Domestic Water Use

Approximately 43 percent of the population in WRPA 4 is served by individually owned water systems. In 1970, farmers and others who furnish their own water withdrew about 21.7 m.g.d. from wells and springs. Table 36 summarizes the rural domestic water use for 1970. All of this water is supplied by ground water sources, and all water withdrawn is considered as consumed.

Table 36 - 1970 Rural Domestic Water Use - WRPA 4[1/]

Subarea	Withdrawal	Consumption
4-1	4.8	4.8
4-2	4.2	4.2
4-3	1.2	1.2
4-4	4.9	4.9
4-5	5.2	5.2
4-6	1.4	1.4
Total WRPA	21.7	21.7

1/ All figures are daily averages in m.g.d.

FUTURE WATER NEEDS

General

The future municipal and industrial water needs for this area will be determined by the area's population, industrial growth and per capita use rate. The population and employment of the WRPA are forecast to decline through 1980 with a continuous rise thereafter.

The municipal water needs will be increased by the continuous movement of people to municipal areas from rural areas and the installation of centrally supplied rural water systems.

The per capita production in industry is forecast to show continuous strong growth. This increased productivity will result in an increased per employee water use for industry which in turn will result in an overall increase in the industrial water needs.

Despite decreases in population, urbanization and increases in employment will result in an increased water use through 1980. After 1980, the increase will become even more pronounced as population, employment, and urbanization continue their upward trend.

Future Municipal Water Needs

The total population of the WRPA is expected to decrease through 1980, but the percentage of the population serviced by municipal type water systems will increase. It is expected that the conversion from

self-supplied to centralized rural or municipal water service will result in 80 percent of the rural population and 100 percent of the urban population being served by central water systems by 2020.

Increased use of indoor plumbing, modern water-using appliances, and extra care in maintenance of possessions, i.e., watering lawns, washing cars, etc., cause an increase in GPCD consumed and therefore is considered in projecting future water needs. The GPCD in WRPA 4 was 147 in 1970 and is projected to increase to 165, 174, and 197 by the years 1980, 2000, and 2020 respectively.

Table 37 shows the projected future water requirements based on the realization of expected trends under the National Income Objective. Table 38 shows the same information based on the realization of expected trends under the Regional Development Objective.

The amount of water treatment needed depends on the quality of the raw water withdrawn and the ability or willingness of the users to pay for the treatment. As new central water systems are initiated or as established systems are expanded, the type of treatment required to insure adequate water quality will vary.

Future Industrial Water Needs

Although projections indicate that the total population of WRPA 4 will decrease through 1980, industries are expected to continue their present trend of increasing productivity Industrial classifications expected to show the most pronounced growth are the textile, chemical, and petroleum refining industries, all of which are major water-using industries.

The future water requirement of an industry is dependent on volume of production, and the processes used. The total industrial output is expected to increase as is the efficiency of the production processes utilized. Examination of these factors along with industrial location trends helps explain the variation of water use among the subareas. Projected water needs range from 14.2 m.g.d. in subarea 4-2 to 584.5 m.g.d. in subarea 4-5 in 2020 under the Regional Development Objective.

Table 39 shows the future industrial water needs for the WRPA under the National Income Objective. Table 40 shows the future industrial water needs for the WRPA under the Regional Development Objective.

Table 37 - Future Municipal Water Needs - WRPA 4[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
4-1	6.0	2.2	8.2	3.0	11.5	4.3
4-2	7.9	2.9	10.8	4.0	15.1	5.6
4-3	4.8	1.8	6.5	2.4	9.0	3.4
4-4	12.1	4.5	16.5	6.2	23.1	8.6
4-5	25.1	9.2	34.4	12.8	48.0	17.9
4-6	9.8	3.6	13.4	5.0	17.0	6.3
Total WRPA	65.7	24.2	89.8	33.4	123.7	46.1

[1/] All figures are daily averages in m.g.d.

Table 38 - Future Municipal Water Needs - WRPA 4[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
4-1	6.6	2.4	9.3	3.4	13.1	4.9
4-2	8.7	3.2	12.2	4.6	17.1	6.4
4-3	5.2	1.9	7.4	2.7	10.2	3.8
4-4	13.3	4.9	18.7	7.0	26.3	9.8
4-5	27.4	10.1	39.0	14.5	54.5	20.3
4-6	10.7	3.9	15.2	5.6	19.2	7.2
Total WRPA	71.9	26.4	101.8	37.8	140.4	52.4

[1/] All figures are daily averages in m.g.d.

Table 39 - Future Industrial Water Needs - WRPA 4[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
4-1	11.9	4.5	22.4	8.5	42.2	16.2
4-2	2.3	1.3	5.4	3.4	12.1	8.0
4-3	3.5	1.0	8.3	2.5	18.6	5.7
4-4	8.7	0.7	20.0	1.6	45.1	3.6
4-5	90.3	1.8	216.0	4.2	495.6	9.6
4-6	18.8	0.6	48.3	1.4	115.7	3.5
Total WRPA	135.5	9.9	320.4	21.6	729.3	46.6

[1/] All figures are daily averages in m.g.d.

Table 40 - Future Industrial Water Needs - WRPA 4[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
4-1	13.1	4.9	26.0	9.9	49.5	19.0
4-2	2.6	1.5	6.2	3.9	14.2	9.5
4-3	3.8	1.2	9.6	2.9	21.9	6.7
4-4	9.6	0.8	23.0	1.9	53.2	4.3
4-5	98.9	1.9	249.9	4.8	584.5	11.3
4-6	20.6	0.6	55.9	1.7	136.4	4.1
Total WRPA	148.6	10.9	370.6	25.1	859.7	54.9

[1/] All figures are daily averages in m.g.d.

Because the industries in the area produce a variety of products, the quality of water required varies considerably. Consequently, so does the amount of treatment required. Industries using water simply for cooling require no special treatment. Food processing industries, however, use treatment similar to that used in the local municipal systems. In all cases, the major factor determining the treatment required to meet established standards are the quality of intake water and its intended use.

Future Thermoelectric Power Water Needs

According to a 1971 survey made by USGS, in 1970 thermoelectric plants in WRPA 4 withdrew 305 m.g.d. for power generation. By the end of 1973, 995 m.g.d. will be withdrawn for power generation. This increase will be the result of completion of plants presently under construction. Based on projected population and average daily per capita kilowatt use, it is expected that thermoelectric plants in the WRPA will produce a surplus of power through 1980. Surpluses are supplied to other areas through the interconnected systems of the Southwest Power Pool members.

Table 41 shows the projected thermoelectric water requirements for WRPA 4.

The quality of the water now used in cooling thermoelectric condensers is generally not a critical factor. The large plants that use once-through cooling water diverted from streams generally only screen out trash that may impede their pumps. The smaller plants which utilize cooling towers to recirculate ground water apply no treatment before use.

Table 41 - Future Thermoelectric Power Water Needs - WRPA 4[1/]

	1980		2000		2020	
	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Withdrawal	995.2	995.2	995.2	1,045.4	1,107.3	1,257.9
Consumption	10.6	10.6	10.6	12.5	14.7	19.8
Return Flow	984.6	984.6	984.6	1,032.9	1,092.6	1,238.1

1/ All figures are daily average in m.g.d.

Future Rural Domestic Water Needs

It is expected that 80 percent of the rural population and 100 percent of the urban population will be served by central water systems by 2020. As a result, the amount of water withdrawn under the rural domestic category will decline through 2020.

Tables 42 and 43 summarize the future rural domestic water needs under the National Income and Regional Development Objectives, respectively.

Table 42 - Future Rural Domestic Water Needs - WRPA 4[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
4-1	4.2	4.2	3.3	3.3	2.5	2.5
4-2	3.7	3.7	2.8	2.8	2.1	2.1
4-3	1.0	1.0	0.8	0.8	0.6	0.6
4-4	4.3	4.3	3.3	3.3	2.5	2.5
4-5	4.5	4.5	3.5	3.5	2.7	2.7
4-6	1.2	1.2	1.0	1.0	0.7	0.7
Total WRPA	18.9	18.9	14.7	14.7	11.1	11.1

[1/] All figures are daily averages in m.g.d.

Table 43 - Future Rural Domestic Water Needs - WRPA 4[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
4-1	4.6	4.6	3.7	3.7	2.8	2.8
4-2	4.0	4.0	3.2	3.2	2.4	2.4
4-3	1.1	1.1	0.9	0.9	0.7	0.7
4-4	4.7	4.7	3.8	3.8	2.9	2.9
4-5	4.9	4.9	4.0	4.0	3.0	3.0
4-6	1.3	1.3	1.1	1.1	0.8	0.8
Total WRPA	20.6	20.6	16.7	16.7	12.6	12.6

[1/] All figures are daily averages in m.g.d.

SUMMARY OF WATER NEEDS

Table 44 is a summary of municipal, industrial, thermoelectric, and rural domestic water needs within WRPA 4.

In evaluation of present resources to determine possible water supply problems, only future municipal, industrial, thermoelectric cooling, and rural domestic needs are considered. Future requirements for other purposes, such as irrigation and other agricultural uses, are presented in other appendixes. Discussion of water shortages anticipated when considering all water uses can be found in the Plan Formulation Appendix.

Table 44 - Summary of Water Needs - WRPA 4[1/]

Use	1970	1980		2000		2020	
		National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Municipal	53.8	65.7	71.9	89.8	101.8	123.7	140.4
Industrial	86.6	135.5	148.6	320.4	370.6	729.3	859.7
Thermoelectric	305.0	995.2	995.2	995.2	1,045.4	1,107.3	1,257.9
Rural Domestic	21.7	18.9	20.6	14.7	16.7	11.1	12.6
Total WRPA	467.1	1,215.3	1,236.3	1,420.1	1,534.5	1,971.4	2,270.6

[1/] All figures are daily average withdrawals in m.g.d.

The comparison of municipal, industrial, thermoelectric, and rural domestic needs to the present availability of water as described in the Regional Climatology, Hydrology and Geology Appendix reveals several possible problem areas. Meeting these needs using current pumping patterns could possibly result in future water shortages in subareas 4-4, 4-5, and 4-6.

W R P A 5

DESCRIPTION

General

WRPA 5 is located in the States of Arkansas and Louisiana and contains the drainage basin of the Ouachita River and its tributaries. Main tributaries of the Ouachita River include the Saline, Caddo, Little Missouri, and Little Rivers and Bayous D'Arbonne, and Bartholomew. Of the nine lakes in the area, one is natural and eight are manmade. The eastern hydrologic boundary of the WRPA is formed by the divides of the Boeuf and Tensas River Basins and the west bank Mississippi River levee in Concordia Parish, La. The southern boundary extends westward from the Mississippi River levee at Black Hawk, La., to the Red River and follows the south bank of the Red River to Boyce, La. The western and northern boundaries are formed by the divides of the Red and Arkansas River Basins, respectively. The northwestern section of the WRPA is predominantly mountains; the northeastern section forms a transition from moutains to rolling hills. The central portion contains a large swamp area, but is predominately rolling hills. The southern portion is alluvial valley. The total drainage area of the WRPA is 20,413 square miles and occupies all or parts of 40 countries and parishes.

Climate

The climate of the WRPA is generally moderate. During winter months the prevailing winds are from the north and northwest. During other seasons prevailing winds are from the south and southwest. The average annual temperature is 65° F. and the average monthly temperatures vary from 45° F. in January to 82° F. in July. The average annual rainfall for the WRPA is 53 inches. The average monthly rainfall varies from a low of 3.0 inches in August, September, and October to a high of 5.8 inches in March.

Economy

The population of the WRPA in 1970 was approximately 822,000, about 13 percent of the total population for the Lower Mississippi Region. Seventy percent of the population of the WRPA was serviced by some form of central water system while 30 percent was not. Municipal water systems serviced 167 communities varying in size from 42 people at Bois D'Arc, Ark., to 60,000 in Pine Bluff, Ark. Of these 167 communities, 32 had populations over 2,5000 and four had populations

of over 20,000; Hot Springs, Pine Bluff, and El Dorado, Ark., and Monroe, La. The total population of the WRPA is projected to be 1,210,000 or 1,377,000 by the year 2020, depending on whether the National Income or Regional Development Objective is realized.

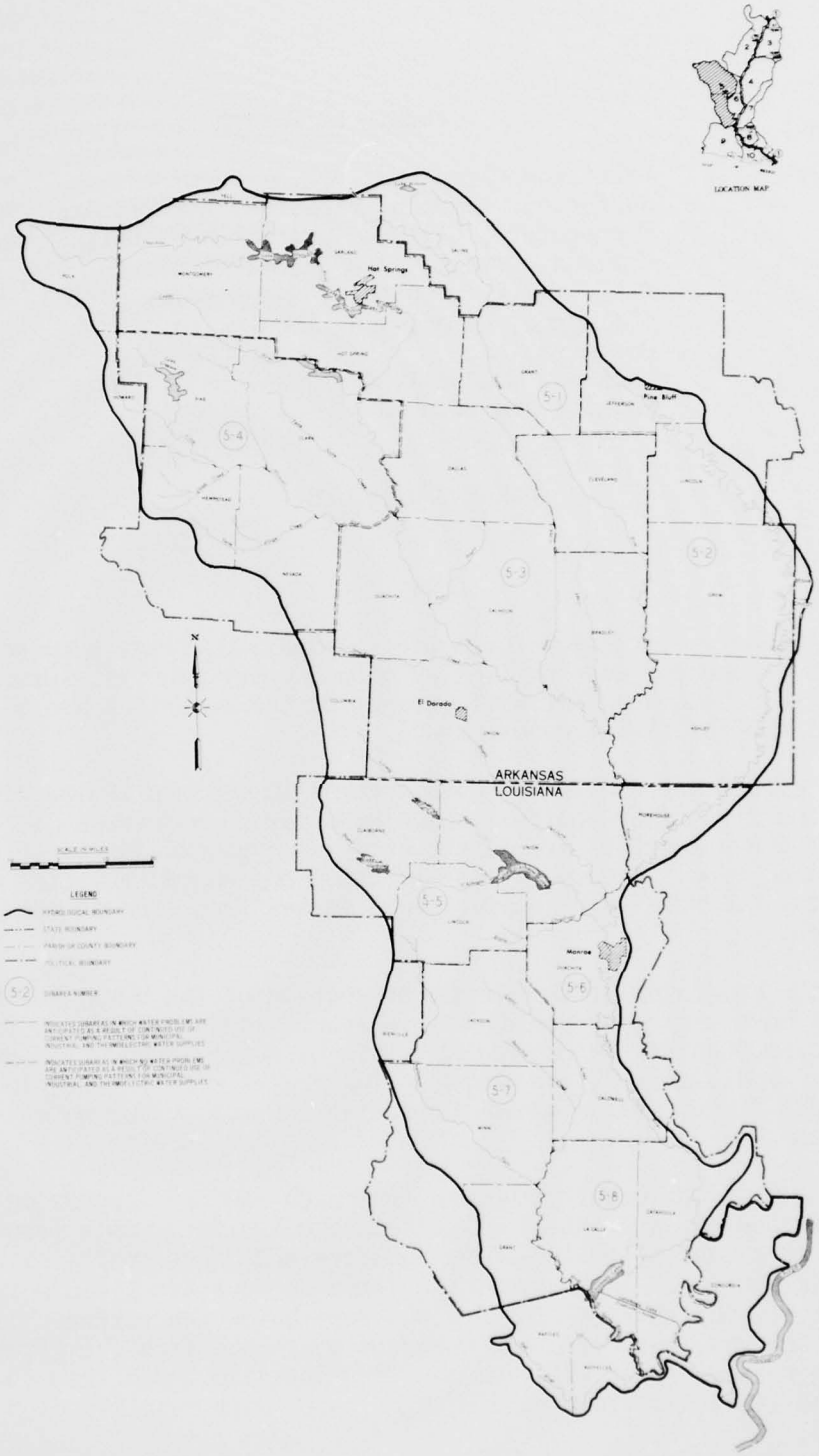
The area's economy is dual-based, relying on agricultural and manufacturing activities. In 1968 production of the manufacturing industries was valued at $555.9 million, and is projected to go as high as $5.2 billion by 3030 if the Regional Development Objective is reached. In 1968, within the WRPA, 273,000 people were employed and had earnings of $1,389.8 million. Of these total earnings, manufacturing industries accounted for 24.7 percent.

There are many important water-using manufacturing industries within the WRPA. Their production of the primary and allied goods of the food, paper , chemical, textile, petroleum, and primary metals require ample quantities of water having acceptable quality. Several industries have constructed private reservoirs within the WRPA to assure a sufficient quantity of unsable water for their production of primary metal and paper products. Storage for water supply has also been incorporated in the DeGray Lake on the Caddo River, a tributary of the Ouachita River.

The economy of this area is influenced by the presence of adequate power sources. There are seven thermoelectric and five hydroelectric generation plants within the WRPA. Although some of the electric power needs of the area are met by plants located outside the WRPA, 1970 data show that thermoelectric plants within the study area generated enough power to satisfy all of the area's power requirements. Additionally, surplus power is provided to the interconnected systems of the Southwest Power Pool members. This is particularly true with relation to the hydroelectric generating facilities that are used primarily to provide power during peak demand periods. This hydroelectric power has been developed for use in the whole Southwestern Power Administration's market area, not just this drainage basin.

Subarea Delineation

WRPA 5 has been divided into eight subareas to make data appraisal more meaningful. This breakdown is selected to approximate the individual drainage sub-basins within the WRPA and then modified to conform to county boundaries. The area of the WRPA thus delineated does not differ appreciably from that of the WRPA defined by hydrologic boundaries (see Figure 6). (In this Appendix, Rapides and Avoyelles Parishes are included in WRPA 9.) This breakdown will allow for better correlation of data within the WRPA and provide a small enough study area to help illuminate problem areas. WRPA 5, when modified to conform to county boundaries, occupies 28 counties. The eight subareas are composed as follows:



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

SUBAREA DELINEATION
MUNICIPAL AND INDUSTRIAL
WATER SUPPLY

WRPA 5

FIGURE 6

Subarea	County or Parish
5-1	Grant and Cleveland, Ark.
5-2	Jefferson, Lincoln, Drew, and Ashley, Ark.
5-3	Montogomery, Garland, Hot Springs, Dallas, Ouachita Calhoun, Bradley, and Union, Ark.
5-4	Pike, Clark, Hempstead, and Nevada, Ark.
5-5	Claiborne, Union, and Lincoln, La.
5-6	Ouachita, La.
5-7	Jackson, Caldwell, Winn, and Grant, La.
5-8	LaSalle and Catahoula, La.

PRESENT WATER USE

General

Of the water withdrawn for municipal and industrial purposes in 1970, 60.1 percent was supplied by ground water sources. Ground water withdrawals accounted for 69.1 percent of the municipal and 57.7 percent of the industrial water used.

The ground water utilized within the WRPA is supplied by five major and five minor aquifers which underlay some portion of the area. None of these aquifers are of the artesian type and one is of the unconfined type. Because of the location and characteristics of these aquifers, the role each aquifer plays varies from area to area within the WRPA.

In the mountains of the northwest section of the WRPA, the aquifer systems have very poor yields. This results in a dependence on the surface sources of the Ouachita, Little Missouri, Caddo, and Saline Rivers. Additionally, the Corps of Engineers' DeGray Lake, located on the Caddo River, was designed to provide 250 m.g.d. for water-supply purposes.

The quality of water withdrawn from each aquifer depends on the minerals and organic matter present in the aquifer. As a result, the exact water quality varies among aquifers and among locations within a single aquifer. In general, the artesian aquifers yield soft water and range in depth from 200 to 4,000 feet below the surface. In some areas, however, only brackish water is available from the artesian aquifer systems. The alluvium aquifer ranges in depth from 40 to 500 feet and its wells yield acidic, hard water with relative high iron content.

Surface water accounted for 39.9 percent of the municipal and industrial water used throughout the WRPA in 1970. The quality of surface water used is influenced by the agricultural, primary metals,

petroleum, and paper manufacturing activities in the area. Streams and rivers in this area have reduced quality due to increased chemical content resulting from the use of fertilizers, pesticides, and herbicides in agricultural activities and from chemical concentrations released by the manufacturing interests of the area. In the lower portions of the WRPA, surface water has a high degree of suspended solids due to sediment loads from agricultural areas. Additionally, the surface water quality is affected by the low to moderate content of dissolved solids, characteristic of the area's ground water effluent.

A more detailed summary of the aquifer discharge rates, thicknesses, locations, water mineral content, and surface water flow information can be found in the Regional Climatology, Hydrology and Geology Appendix.

1970 Municipal Water Use

In 1970, the average daily municipal water withdrawal within the WRPA was 54.3 m.g.d., of which 37.5 m.g.d. was supplied by ground water and 16.8 m.g.d. was supplied by surface sources. This withdrawal is equivalent to an average daily per capita use of 117 gallons in areas serviced by central water systems, as compared to the national average of 166 GPCD. The peak month for municipal water withdrawal was July, with an average daily withdrawal of 77.7 million gallons.

Withdrawal requirements far exceed actual consumptive use. This is reflected in data collected nationwide indicating that 63 percent of water withdrawn for municipal use is returned to a stream and made available for re-use.

Municipal water pumpages by county and major water users are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use. Table 45 gives a breakdown, by subarea, of the 1970 municipal water withdrawals.

As previously mentioned, the water quality within the WRPA varies according to the source. Ground water quality varies according to the type aquifer and aquifer composition and the location of the well in the aquifer. Surface water quality varies according to the intakes' location to the agricultural and manufacturing interests of the WRPA and the ground water effluents dissolved solids concentrations. In turn, the quality of the raw intake water governs the degree of treatment required prior to use. Accordingly, the method of treatment varies widely throughout the WRPA, from a simple chlorination process in some communities to elaborate systems of chlorination, aeration, filtration, fluoridation, flocculation, and pH correction in others.

In all cases, the actual amount of treatment performed is dependent on the quality of the raw water and the ability or willingness of the users to pay for its treatment.

Table 45 - 1970 Municipal Water Use - WRPA 5[1/]

Subarea	Withdrawal		Total Consumption
	Ground water	Surface water	
5-1	0.9	0.0	0.4
5-2	11.9	0.0	4.4
5-3	6.6	7.5	5.2
5-4	2.1	1.6	1.4
5-5	5.5	0.0	2.1
5-6	4.8	7.7	4.6
5-7	3.0	0.0[2/]	1.1
5-8	2.7	0.0	1.0
Total WRPA	37.5	16.8	20.2

1/ All figures are daily averages in m.g.d.
2/ Less than 0.1 m.g.d.

1970 Industrial Water Use

Industrial activity within WRPA 5 during 1970 required a daily average water withdrawal of 206.7 m.g.d. Ground water supplied 57.7 percent of this withdrawal and surface sources supplied 42.3 percent.

Industrial water pumpages by subarea are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use. Table 46 gives a breakdown by subarea of the 1970 industrial water withdrawals.

Table 46 - 1970 Industrial Water Use - WRPA 5[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
5-1	0.5	0.0[2/]	0.2
5-2	65.0	40.0	24.6
5-3	23.1	22.7	19.3
5-4	1.3	2.1	2.6
5-5	3.3	0.4	2.0
5-6	10.7	20.6	10.1
5-7	15.2	1.2	9.0
5-8	0.2	0.4	0.4
Total WRPA	119.3	87.4	68.2

1/ All figures are daily averages in m.g.d.
2/ Less than 0.1 m.g.d.

In subarea 5-1, the industries utilizing the bulk of the 0.5. m.g.d. produced aluminum castings and finished wood products. In subarea 5-2, large volumes of water are used by the paper, chemical, metal casting, and drilling mud compound industries. Subarea 5-3 uses large amounts of surface and ground water in the aluminum, paper products, petroleum, wood products, concrete products, and chemical industries. Subarea 5-4 uses most of its water in the aluminum and lumber products industries. The water in subarea 5-6 is used predominately in the production of chemical and paper products. In subarea 5-7, paper and lumber products use the majority of the water. Subareas 5-5 and 5-8 do not have any large independent water-using industries.

Because the industries in WRPA 5 produce a wide variety of goods and receive their water from such a wide variety of sources, each industry has its own water quality requirements and subsequent treatment. The degree of treatment ranges from no treatment in industries using water as a cooling agent for bearings or condensers, to flocculation for surface water use in the paper and petroleum industries, to a full five-step system of treatment in some food producing industries. These systems were previously mentioned under 1970 Municipal Water Use. In the final analysis, however, the quality of the raw intake water and its intended use will govern the type of treatment required for the various industrial processes for which it will be used.

1970 Thermoelectric Power Water Use

Because of the large volume of water required to cool condensers in thermoelectric units, all plants in WRPA 5 either use surface water for cooling purposes or use ground water recirculated through cooling towers. The seven thermoelectric plants in WRPA 5 are located at Hot Springs and Camden, Ark., and Sterlington, Monroe, Ruston, Homer, and Jonesboro, La. No new plants are under construction at this time. These seven existing plants are currently producing enough power to meet the electric power requirements for the WRPA and supply surplus power to the interconnected systems of the Southwest Power Pool members. Additional power is supplied during peak demand periods by three Corps of Engineers-operated hydroelectric plants and two privately owned plants within the area. More information on both types of power is available in the Power Appendix.

Table 47 indicates the 1970 thermoelectric water withdrawals for WRPA 5.

Of the seven thermoelectric plants within the WRPA, four utilize surface water and three use ground water; two of the latter operate off of the city water systems. The plants which use ground water or city system water are similar and produce power for their immediate.

area, i.e., the city or county in which they are located. The four plants using surface water are large compared to the plants using ground water and supply power over a greater area, including portions of other states. The water used by these plants is withdrawn from Lake Catherine and the Ouachita River.

Table 47 - 1970 Thermoelectric Power Water Use - WRPA 5[1/]

	Ground	Surface	Total
Withdrawal	0.3	1,070.7	1,071.0
Consumption	0.3	9.5	9.8
Return Flow	0.0	1,061.2	1,061.2

[1/] All figures are daily averages in m.g.d.

1970 Rural Domestic Water Use

Approximately 30 percent of the population of WRPA 5 is presently served by individually owned water systems. In 1970, farmers and others who furnished their own water supplies withdrew about 16.1 m.g.d. from wells and springs.

Table 48 summarizes the rural domestic water withdrawals for 1970. All of this water is supplied by ground water sources and is considered as consumed.

Table 48 - 1970 Rural Domestic Water Use - WRPA 5[1/]

Subarea	Withdrawal	Consumption
5-1	0.9	0.9
5-2	3.2	3.2
5-3	4.7	4.7
5-4	2.1	2.1
5-5	2.2	2.2
5-6	0.3	0.3
5-7	1.8	1.8
5-8	0.9	0.9
Total WRPA	16.1	16.1

[1/] All figures are daily averages in m.g.d.

FUTURE WATER NEEDS

General

The future municipal and industrial water needs for this area will be determined by the area's population, industrial growth, and per capita use rate. The population, water use rate, and industrial production of the WRPA is forecast to continue increasing through 2020.

The municipal water needs will be increased by the rise in population, the continuous movement of people to municipal areas from rural areas, and the installation of centrally supplied rural water systems.

The per capita production in industry is forecast to show continuous strong growth. This increased productivity will result in an increased per employee water use, which in turn will result in an overall increase in the industrial water needs.

Along with increases in population and employment, urbanization and improved industrial technology will result in an ever increasing water use.

Future Municipal Water Needs

The total population of the WRPA is expected to increase through 2020, while the population serviced by municipal water distribution systems will increase at a greater rate. It is expected that the conversion from self-supplied to centralized rural or municipal water service will result in 80 percent of the rural population and 100 percent of the urban population being serviced by central water systems by 2020.

Increased use of modern water-using appliances, and exta care in maintenance of possessions, i.e., watering lawns, washing cars, etc., will cause an increase in GPCD consumed and therefore is considered in projecting future water needs. The GPCD in WRPA 5 was 117 in 1970 and is projected to increase to 128, 137, and 147 by the years 1980, 2000, and 2020, respectively.

Tables 49 and 50 show the projected future water requirements based on the realization of expected trends under the National Income and Regional Development Objectives, respectively.

Table 49 - Future Municipal Water Needs - WRPA 5[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
5-1	1.2	0.4	1.7	0.6	2.5	0.9
5-2	15.1	5.6	21.1	7.8	30.9	11.5
5-3	17.6	6.5	24.9	9.3	36.3	13.6
5-4	4.6	1.7	6.5	2.4	9.5	3.5
5-5	6.3	2.3	8.5	3.2	15.5	5.8
5-6	14.5	5.3	18.3	6.8	23.0	8.6
5-7	3.5	1.3	4.7	1.8	8.6	3.2
5-8	3.1	1.1	4.1	1.5	7.5	2.8
Total WRPA	65.9	24.2	89.8	33.4	133.8	49.9

[1/] All figures are daily averages in m.g.d.

Table 50 - Future Municipal Water Needs - WRPA 5[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
5-1	1.3	0.5	1.9	0.7	2.8	1.0
5-2	16.0	5.9	23.9	8.9	35.2	13.1
5-3	18.7	6.9	28.3	10.5	41.3	15.4
5-4	4.9	1.8	7.4	2.8	10.8	4.0
5-5	6.7	2.5	9.6	3.6	17.6	6.6
5-6	15.4	5.6	20.7	7.7	26.2	9.8
5-7	3.7	1.4	5.4	2.0	9.8	3.7
5-8	3.3	1.2	4.7	1.7	8.5	3.2
Total WRPA	70.0	25.8	101.9	37.9	152.2	56.8

[1/] All figures are daily averages in m.g.d.

The amount of water treatment received depends on the quality of the raw water withdrawn and the ability or willingness of the users to pay for the treatment. As new central water systems are initiated or as established systems are expanded, the type of treatment required to insure adequate water quality will vary.

Future Industrial Water Needs

Projections indicate that the employment in WRPA 5 will increase during the time period 1980-2020 and industries will continue their present trend of increased productivity. Industrial classifications expected to show the most pronounced growth are the paper, chemical, petroleum, and primary metals industries, all of which are major water-using industries.

The future water requirement of an industry is dependent on the volumes of production and the industrial processes used. Both total production and efficiency of water use are expected to increase. These factors along with industrial location trends, are responsible for the the variation of water use among the subareas. Projected water needs range from 5.7 m.g.d. in subarea 5-8 to 1,019.0 m.g.d. in subarea 5-2 in 2020 under the Regional Development Objective.

Tables 51 and 52 show the future industrial water needs for the WRPA under the National Income and Regional Development Objectives, respectively.

Table 51 - Future Industrial Water Needs - WRPA 5[1/]
National Income Objective (Program A)

Sub area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
5-1	0.8	0.4	1.9	0.9	4.3	2.1
5-2	162.9	38.6	379.9	91.1	864.0	205.7
5-3	65.6	27.8	151.1	65.0	334.8	144.3
5-4	5.3	4.1	12.5	9.6	27.9	21.5
5-5	5.7	3.2	12.6	7.8	26.9	17.5
5-6	43.1	13.9	79.6	26.2	149.8	50.4
5-7	23.1	12.3	44.2	22.2	85.3	40.7
5-8	0.9	0.7	2.1	1.7	4.8	3.8
Total WRPA	307.4	101.0	683.9	224.5	1,497.8	486.0

[1/] All figures are daily averages in m.g.d.

Table 52 - Future Industrial Water Needs - WRPA 5[1/]
Regional Development (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
5-1	0.9	0.4	2.2	1.1	5.0	2.5
5-2	178.6	42.4	440.7	105.5	1,019.0	242.7
5-3	79.7	33.9	190.4	81.7	431.8	185.9
5-4	5.9	4.5	14.4	11.1	32.9	25.3
5-5	7.2	4.5	14.6	9.0	31.8	20.6
5-6	47.3	15.3	92.4	30.3	176.7	59.5
5-7	25.3	13.5	51.3	25.8	100.6	48.0
5-8	1.0	0.8	2.5	2.0	5.7	4.5
Total WRPA	345.9	115.3	808.5	266.5	1,803.5	589.0

[1/] All figures are daily averages in m.g.d.

Because the industries in the area market a variety of products, the quality of water required varies considerably. Consequently, so does the amount of treatment required. Industries using water simply for cooling require no special treatment. Food-processing industries, however, use treatment similar to that used in the local municipal systems. In all cases, the factors determining the treatment required will be the quality of intake water and its intended use.

Future Thermoelectric Power Water Needs

According to a 1971 study made by the United States Geological Survey (USGS), thermoelectric plants in WRPA 5 withdrew 1,071 m.g.d. for power generation in 1970. Based on projected population and average daily per capita kilowatt use, it is expected that thermoelectric plants in the WRPA will produce a surplus of power through 1980. Surpluses are supplied to other areas served by the interconnected systems of the Southwest Power Pool members.

Table 53 shows the projected thermoelectric power water requirements for WRPA 5.

The quality of the water used in cooling thermoelectric condensers is generally not a critical factor. The large plants that use once-through cooling water diverted from streams generally only screen out trash that may impede their pumps. The smaller plants which utilize cooling towers to recirculate ground water apply no treatment before use.

Table 53 - Future Thermoelectric Power Water Needs - WRPA 5[1/]

Subarea	1980		2000		2020	
	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Withdrawal	1,071.0	1,071.0	2,905.2	3,294.5	3,441.6	3,916.5
Consumption	9.8	9.8	34.6	39.3	54.3	61.8
Return Flow	1,061.2	1,061.2	2,870.6	3,255.2	3,387.3	3,854.7

[1/] All figures are daily average in m.g.d.

Future Rural Domestic Water Needs

It is expected that only 20 percent of the rural population will be serviced by private systems by 2020. As a result, the amount of water withdrawn under the rural domestic category will decline through 2020. Tables 54 and 55 summarize the future rural domestic water needs under the National Income and Regional Development Objectives, respectively.

Table 54 - Future Rural Domestic Water Needs - WRPA 5[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
5-1	0.8	0.8	0.7	0.7	0.3	0.3
5-2	2.8	2.8	2.4	2.4	1.1	1.1
5-3	4.2	4.2	3.5	3.5	1.6	1.6
5-4	1.9	1.9	1.6	1.6	0.7	0.7
5-5	2.0	2.0	1.7	1.7	0.8	0.8
5-6	0.3	0.3	0.2	0.2	0.1	0.1
5-7	1.6	1.6	1.4	1.4	0.6	0.6
5-8	0.8	0.8	0.7	0.7	0.3	0.3
Total WRPA	14.4	14.4	12.2	12.2	5.5	5.5

[1/] All figures are daily averages in m.g.d.

Table 55 - Future Rural Domestic Water Needs - WRPA 5[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
5-1	0.8	0.8	0.8	0.8	0.4	0.4
5-2	3.0	3.0	2.8	2.8	1.2	1.2
5-3	4.5	4.5	4.0	4.0	1.8	1.8
5-4	2.0	2.0	1.8	1.8	0.8	0.8
5-5	2.1	2.1	1.9	1.9	0.9	0.9
5-6	0.3	0.3	0.3	0.3	0.1	0.1
5-7	1.7	1.7	1.5	1.5	0.7	0.7
5-8	0.9	0.9	0.8	0.8	0.4	0.4
Total WRPA	15.3	15.3	13.9	13.9	6.3	6.3

[1/] All figures are daily averages in m.g.d.

Summary of Water Needs

Table 56 is a summary of municipal, industrial, thermoelectric, and rural domestic water needs within WRPA 5.

In evaluation of present resources to determine possible water supply problems, only future municipal, industrial, thermoelectric cooling, and rural domestic needs are considered. Future requirements for purposes such as irrigation and other agricultural uses are considered in other appendixes. Discussion of water shortages anticipated when considering all water uses can be found in the Plan Formulation Appendix.

The comparison of municipal, industrial, thermoelectric, and rural domestic needs to the present availablity of water as described in the Regional Climatology, Hydrology and Geology Appendix reveals several possible problem areas. Meeting these needs using current pumping patterns could possibly result in future water shortages in subareas 5-2 and 5-4.

Table 56 - Summary of Water Needs - WRPA 5[1/]

Use	1970	1980		2000		2020	
		National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Municipal	54.3	65.9	70.0	89.8	101.9	133.8	152.2
Industrial	206.7	591.4	669.9	1,343.8	1,598.1	2,979.3	3,610.9
Thermoelectric	1,071.0	1,071.0	1,071.0	2,905.2	3,294.5	3,441.6	3,916.5
Rural Domestic	16.1	14.4	15.3	12.2	13.9	5.5	6.3
Total WRPA	1,348.1	1,742.7	1,826.2	4,351.0	5,008.4	6,560.2	7,685.9

[1/] All figures are daily average withdrawals in m.g.d.

W R P A 6

DESCRIPTION

General

WRPA 6 is located in the States of Arkansas and Louisiana. The northern boundary follows the south bank of the Arkansas River from the Mississippi River to a point just south of Pine Bluff, Ark. The eastern boundary follows the west side of the Mississippi River levee from the mouth of the Arkansas River to the vicinity of Ferriday, La. The western boundary follows the eastern hydrological divide of Bayou Bartholomew and the Ouachita River to the confluence of the Tensas and Ouachita Rivers. The total area of WRPA 6 is 5,520 square miles, comprising all or part of 15 counties and parishes. The surface area of the WRPA is generally flat, with a general slope from north to south. Two ridge lines are found within the area. The first traverses the central portion between Eudora, Ark., and Sicily Island, La.; the other is located on the western side of the basin and extends from about 10 miles above Bastrop, La., to the vicinity of Monroe, La.

Climate

The climate of the WRPA is generally mild with the average temperature varying from 48° F. in winter to 81° F. in summer. The average annual temperature for the area is 65° F. The prevailing winds are generally from the southwest during the summer and the north during the winter. The distribution of rainfall is fairly uniform over the watersheds with the average annual amount being 52 inches. Heavy winter and spring rains are characteristic. Average monthly rainfall varies from about 3 to 6 inches, with more than 4 inches per month being experienced from November through May.

Economy

The population of the WRPA in 1970 was approximately 188,000, about 3 percent of the total population of the Lower Mississippi Region. Fifty-five percent of the population of the WRPA was serviced by some form of central water system. Municipal water systems serviced 43 communities varying in size from 33 people at Lake Bruin, La., to almost 20,000 people at Bastrop, La. The total population of the WRPA is projected to be 193,000 or 212,000 by the year 2020. depending on whether the National Income or Regional Development Objective is realized.

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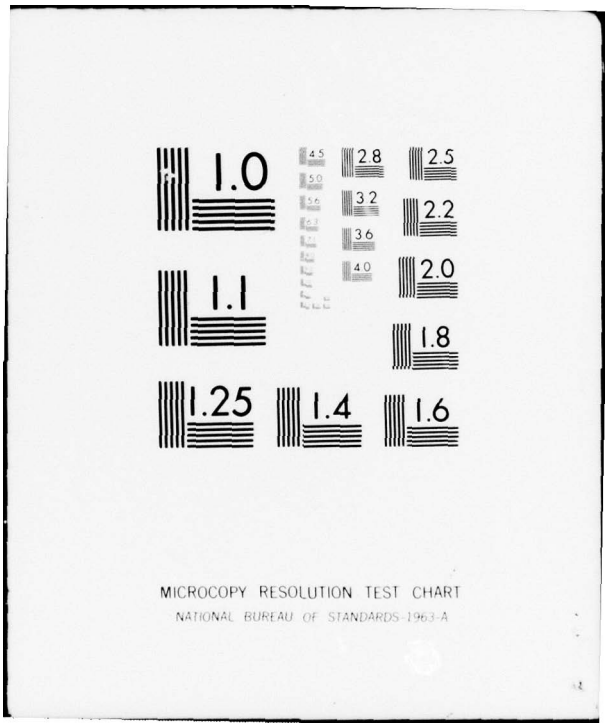
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

The economy of the area is agriculture-based, but manufacturing and other industries also make considerable contributions. Manufacturing earnings accounted for over 12 percent of the total earnings within the WRPA in 1968. The abundant fertile land in WRPA 6 is the most valuable resource. Agricultural earnings of $143.7 million in 1968 represented over one-third of the total earnings in WRPA 6. The principal agricultural commodities are cotton, soybeans, rice, corn, small grains, beef, and timber.

The 1968 employment in WRPA 6 was 53,700 having earnings of $291.3 million (reference: Economics Appendix).

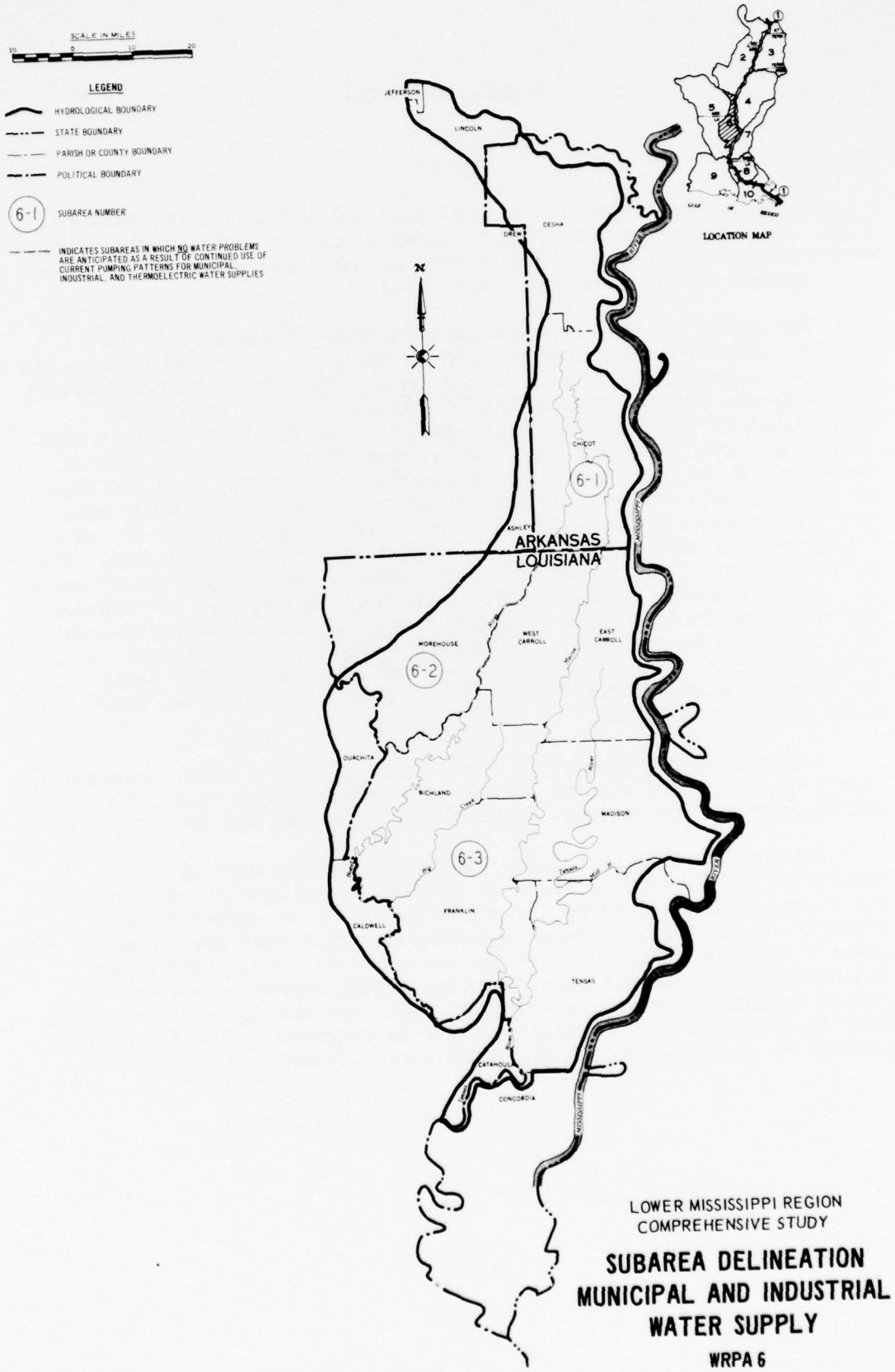
There are several important water-using manufacturing industries within the WRPA. Their production of the primary and allied goods of the food, chemical, paper, and petroleum industries requires ample quantities of water having acceptable quality.

There is one thermoelectric power plant within WRPA 6. Based on the average per capita power requirements, WRPA 6 did not produce sufficient power during 1970 within its boundaries to meet its power needs. The additional power that was required was supplied through the interconnected systems of the Southwest Power Pool members.

Subarea Delineation

WRPA 6 has been divided into three subareas to make data appraisal more meaningful. This breakdown is selected based on the hydrological boundaries and then modified to conform to county boundaries (see Figure 7). This breakdown will allow for better correlation of data within the WRPA and provide a small enough study area to help illuminate problem areas. The three subareas are composed as follows:

Subarea	County or Parish
6-1	Desha and Chicot, Ark.
6-2	Morehouse, La.
6-3	West Carroll, East Carroll, Richland, Madison, Franklin, Tensas, Concordia, La.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LEGEND
HYDROLOGICAL BOUNDARY
STATE BOUNDARY
PARISH OR COUNTY BOUNDARY
POLITICAL BOUNDARY
6-1 SUBAREA NUMBER
INDICATES SUBAREAS IN WHICH NO WATER PROBLEMS ARE ANTICIPATED AS A RESULT OF CONTINUED USE OF CURRENT PUMPING PATTERNS FOR MUNICIPAL, INDUSTRIAL, AND THERMOELECTRIC WATER SUPPLIES
N
LOCATION MAP
JEFFERSON
LINCOLN
DESHA
CHICOT
6-1
ASHLEY
ARKANSAS
LOUISIANA
MOREHOUSE
WEST CARROLL
EAST CARROLL
6-2
OUACHITA
RICHLAND
MADISON
6-3
FRANKLIN
CALDWELL
TENSAS
CATAHOULA
CONCORDIA
MISSISSIPPI
LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY
SUBAREA DELINEATION
MUNICIPAL AND INDUSTRIAL
WATER SUPPLY
WRPA 6

FIGURE 7

PRESENT WATER USE

General

Of the water withdrawn for municipal and industrial purposes in 1970, 51.6 percent was supplied by ground water sources. Ground water withdrawals accounted for 92.6 percent of the municipal water used and 46.2 percent of the industrial water used.

The ground water utilized within the WRPA is supplied by four aquifers which underlie some portion of the area. Of these four aquifers, three are artesian and one is of the unconfined type. About 95 percent of the ground water pumped in the WRPA comes from the unconfined Mississippi River Valley alluvial aquifer. The thickness of this aquifer ranges from 50 to 150 feet, but is more than 100 feet in most of the area. Water from the alluvial aquifer is generally hard and high in iron content; however, exceptions exist in some upland areas where the terrace deposits are exposed. The thickness of the artesian aquifers generally ranges from less than 100 to more than 1,000 feet. One aquifer (Sparta Sand) underlies all of WRPA 6, but contains salty water in most of the area. It contains fresh water in one area in Arkansas and two areas in Louisiana. The remaining aquifers contain fresh water of a soft bicarbonate type. The micocene deposits underlie only a very small part of the southern tip of the area and overlie salty water. The miocene sands are not considered a significant source of fresh water supplies in WRPA 6.

A more detailed summary of the aquifer discharge rates, thickness, locations, and water mineral content and surface water flow information can be found in the Regional Climatology, Hydrology and Geology Appendix.

A limited amount of surface water is presently used by some industries in the lower portion of the WRPA. The quality of surface water used is influenced by the extensive amount of agricultural activity in the area. Streams and rivers in this area have high chemical content resulting from the use of fertilizers, pesticides, and herbicides. Surface water also has a high degree of suspended solids because of increased sediment loads from the agricultural areas. Additionally, the surface water quality is degraded by low to moderate content of dissolved solids in ground water effluent.

1970 Municipal Water Use

In 1970, the average daily municipal water withdrawal within the WRPA was 7.5 million gallons of ground water and 0.6 million gallons of surface water. This withdrawal resulted in a 78 GPCD use in areas serviced by central water systems, as compared to the national average of 166 GPCD. During July, the peak municipal water-use month, the average daily water use was 9.2 m.g.d., of which approximately 0.7 m.g.d. was surface water.

Withdrawal requirements far exceed actual consumptive use. This is reflected by a water intake of 8.1 m.g.d. compared to water consumption of 3.0 m.g.d. This gives a return flow of 63 percent to the streams and made available for re-use.

Municipal water pumpages by county and major users are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use. Table 57 gives a breakdown, by subarea, of the 1970 municipal water withdrawals.

Table 57 - 1970 Municipal Water Use - WRPA 6[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
6-1	2.0	0.0	0.7
6-2	1.2	0.0	0.5
6-3,	4.3	0.6	1.8
Total WRPA	7.5	0.6	3.0

1/All figures are daily averages in m.g.d.

The quality of the raw water and its intended use principally govern the degree of treatment required. The amount of treatment is dependent on the quality of the raw water, its intended use, and the willingness or ability of the user to pay for treatment. Within WRPA 6, the treatment varies from chlorination to combinations of processes, such as aeration, chlorination, filtration, fluoridation, and pH correction.

1970 Industrial Water Use

Industrial activity within WRPA 6 during 1970 required a daily average water withdrawal of 61.5 million gallons. Ground water supplied 46.2 percent of this withdrawal and surface sources supplied 53.8 percent.

Industrial water pumpages by subarea are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use. Table 58 gives a breakdown by subarea of the 1970 industrial water withdrawals.

Table 58 - 1970 Industrial Water Use - WRPA 6[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
6-1	0.3	0.0	0.2
6-2	27.0	33.1	6.0
6-3	1.1	0.0[2/]	0.3
Total WRPA	28.4	33.1	6.5

[1/] All figures are daily averages in m.g.d.

[2/] Less than 0.1 m.g.d.

Included within the 141 manufacturing establishments are the six major water-using industries. None of these industries, with the exception of the paper industry, is a large independent water user. Industries falling under the "other manufacturing" category accounted for about 99 percent of the total water withdrawn in 1970. Principal among the "other manufacturing" industries were the lumber and furniture industry and the apparel and other textiles industry. Because the industries in the WRPA produce a wide variety of goods, each industry has its own water quality requirements and subsequent treatment. The degree of treatment ranges from no treatment in industries using raw intake water as a cooling agent for bearings or condensers to a full five-step system of treatment in some food-producing industries.

The quality of the raw intake water and its intended use will govern the type of treatment required for the various industrial processes.

1970 Thermoelectric Power Water Use

Presently there is only one thermoelectric power plant in WRPA 6. This plant, located at Rayville, La., utilizes ground water as its cooling source. Sufficient electrical power cannot be supplied by the one plant at Rayville to meet the electrical demands of the area; therefore, additional power is supplied through the interconnected systems of the Southwest Power Pool members. Table 59 indicates the 1970 thermelectric water withdrawals for WRPA 6.

Table 59 - 1970 Thermoelectric Power Water Use - WRPA 6[1/]

	Ground	Surface	Total
Withdrawal	0.3	0.0	0.3
Consumption	0.3	0.0	0.3
Return Flow	0.0[2/]	0.0	0.0

1/ All figures are daily averages in m.g.d.

2/ The thermoelectric plant utilizes cooling towers. Water withdrawn is for makeup purposes - to replace evaporation losses, drift, etc. Therefore, there is no return flow.

1970 Rural Domestic Water Use

Approximately 45 percent of the population of WRPA 6 is presently served by individual water systems. In 1970, farmers and others who furnished their own water supplies withdrew about 6.7 m.g.d. from wells and springs. The per capita pumpage for rural use water varies, depending upon whether or not the household has an internal distribution system. Those homes in Arkansas having such a system use 77 GPCD, while those homes having no inside system use 20 GPCD; in Louisiana, these homes use 60 GPCD and 10 GPCD, respectively. Table 60 summarizes the rural domestic water use of 1970. All of this water is supplied by ground water sources, and is considered as consumed.

Table 60 - 1970 Rural Domestic Water Use - WRPA 6[1/]

Subarea	Withdrawal	Consumption
6-1	1.2	1.2
6-2	1.2	1.2
6-3	4.3	4.3
Total WRPA	6.7	6.7

1/ All figures are daily averages in m.g.d.

FUTURE WATER NEEDS

General

The future municipal and industrial water needs for this area will be determined by the area's population, industrial growth, and per capita use rate. Population changes for the area are substantially different from the continuing increases expected for the Nation and Lower Mississippi Region. The present decline is expected to continue during the next decade with a gradual increase occurring thereafter. The projected 2020 population is almost equal to the present population, reflecting the extent to which growth in the area remains below that for other areas.

The municipal water needs will be increased by the continuous movement of people to municipal areas from rural areas and the installation of centrally supplied rural water systems.

The per capita production in industry is forecast to show continuous strong growth. This increased productivity will result in an increased per employee water-use for industry which, in turn, will result in an overall increase in the industrial water needs.

Employment is projected to steadily increase after 1980. The 2020 employment will be 67,000 or 78,000, depending on whether the National Income or Regional Development Objective is realized. The increase in employment and the movement from rural to municipal areas will result in an increased water use through the year 2020.

Future Municipal Water Needs

The total population of the WRPA is expected to decrease through 1980, but the percentage of the population serviced by municipal water distribution systems will increase. It is expected that the conversion from self-supplied to centralized rural or municipal water service will result in 80 percent of the rural population and 100 percent of the urban population being served by central water systems by 2020.

Increased use of indoor plumbing and modern water-using appliances and extra care in the maintenance of possessions will cause an increase in GPCD and therefore are considered in projecting future water needs. The GPCD in WRPA 6 was 78 in 1970 and is projected to increase to 81, 87, and 92 by the years 1980, 2000, and 2020, respectively.

Tables 61 and 62 show the projected future water requirements based on the realization of expected trends under the National Income and Regional Development Objectives, respectively.

Table 61 - Future Municipal Water Needs - WRPA 6[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
6-1	2.4	0.9	3.0	1.1	3.9	1.4
6-2	1.4	0.5	1.8	0.7	2.3	0.9
6-3	5.3	2.0	6.6	2.4	8.5	3.2
Total WRPA	9.1	3.4	11.4	4.2	14.7	5.5

[1/] All figures are daily averages in m.g.d.

Table 62 - Future Municipal Water Needs - WRPA 6[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
6-1	2.6	0.9	3.1	1.1	4.3	1.6
6-2	1.5	0.6	1.9	0.7	2.6	1.0
6-3	5.7	2.1	6.9	2.6	9.3	3.5
Total WRPA	9.8	3.6	11.9	4.4	16.2	6.1

[1/] All figures are daily averages in m.g.d.

The amount of water treatment received depends on the quality of the raw water withdrawn and the ability or willingness of the user to pay for the treatment. As new central water systems are initiated or as established systems are expanded, the type of treatment required to insure adequate water quality will vary.

Future Industrial Water Needs

Although projections indicate that the total population of WRPA 6 will decrease through the year 2000, industries are expected to continue their present trend of increasing productivity. A detailed presentation of earnings by specific industry is prohibited by disclosure problems.

The future water requirement of an industry is dependent on both the volume of production and the processes used. The total industrial production is expected to increase as is the efficiency of the processes used. These factors along with industrial location trends account for the variation of water use among the subareas. Projected water needs range from 2.6 m.g.d. in subarea 6-1 to 296.3 m.g.d. in subarea 6-2 in the year 2020 under the Regional Development Objective. By the year 2020, the total industrial water needs are forecast to be 95 percent of the total municipal-industrial water used in the area.

Tables 63 and 64 show the future industrial water needs for the WRPA under the National Income and Regional Development Objectives, respectively.

Table 63 - Future Industrial Water Needs - WRPA 6[1]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
6-1	0.5	0.2	1.0	0.5	2.2	1.1
6-2	68.8	7.7	131.4	15.9	252.4	32.6
6-3	2.0	0.4	3.5	0.7	6.7	1.3
Total WRPA	71.3	8.3	135.9	17.1	261.3	35.0

1/ All figures are daily averages in m.g.d.

Table 64 - Future Industrial Water Needs - WRPA 6[1/]
Regional Development Objective (Program B)

Sub area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
6-1	0.5	0.3	1.2	0.6	2.6	1.3
6-2	76.1	8.6	151.9	18.4	296.3	38.3
6-3	2.3	0.4	4.1	0.8	7.9	1.6
Total WRPA	78.9	9.3	157.2	19.8	306.8	41.2

1/ All figures are daily averages in m.g.d.

Because the industries in the area produce a variety of products, the quality of water required varies considerably. Consequently, so does the amount of treatment required. Industries using water simply for cooling require no special treatment. Food-processing industries, however, use treatment similar to that used in the local municipal systems. In all cases, the factor determining the treatment required will be the quality of intake water and its intended use.

Future Thermoelectric Power Water Needs

According to a 1971 survey made by USGS, thermoelectric plants in WRPA 6 withdrew 0.3 m.g.d. for power generation. At present, there are no new plants being constructed. The power generated by the one thermoelectric plant is not sufficient to supply the power needs of the entire WRPA and additional power has to be imported from other sources.

Table 65 shows the projected thermoelectric water requirements for WRPA 6.

The quality of the water used in cooling thermoelectric condensers is generally not a critical factor. The large plants that use once-through cooling water diverted from streams generally only screen out trash that may impede their pumps. The smaller plants which utilize cooling towers to recirculate ground water apply no treatment before use.

Table 65 - Future Thermoelectric Power Water Needs - WRPA 6[1/]

	1980		2000		2020	
Subarea	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Withdrawal	82.3	97.1	547.8	575.1	649.8	713.5
Consumption	.9	1.0	6.5	6.9	10.3	11.3
Return Flow	81.4	96.1	541.3	568.2	639.5	702.2

[1/] All figures are daily averages in m.g.d.

Future Rural Domestic Water Needs

It is expected that only 20 percent of a decreasing rural population will be serviced by private systems by 2020. As a result, the amount of water withdrawn under the rural domestic category will decline through 2020. Tables 66 and 67 summarize the future rural domestic water needs under the National Income and Regional Development Objectives, respectively.

Summary of Water Needs

Table 68 is a summary of municipal, industrial, thermoelectric, and rural domestic water needs within WRPA 6.

In evaluation of present resources to determine possible water supply problems. Only future municipal, industrial, thermoelectric, and rural domestic cooling needs are considered. Future requirements for purposes such as irrigation and other agricultural uses are considered in other appendixes. Discussion of water shortages anticipated when considering all water uses can be found in the Plan Formulation Appendix.

The comparison of municipal, industrial, thermoelectric, and rural domestic needs to the present availability of water, as described in the Regional Climatology, Hydrology and Geology Appendix, reveals no problem areas within WRPA 6.

Table 66 - Future Rural Domestic Water Needs - WRPA 6[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
6-1	0.9	0.9	0.7	0.7	0.5	0.5
6-2	0.9	0.9	0.7	0.7	0.5	0.5
6-3	3.4	3.4	2.5	2.5	1.7	1.7
Total WRPA	5.2	5.2	3.9	3.9	2.7	2.7

[1/] All figures are daily averages in m.g.d.

Table 67 - Future Rural Domestic Water Needs - WRPA 6[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
6-1	1.0	1.0	0.7	0.7	0.5	0.5
6-2	1.0	1.0	0.7	0.7	0.5	0.5
6-3	3.6	3.6	2.6	2.6	1.9	1.9
Total WRPA	5.6	5.6	4.0	4.0	2.9	2.9

[1/] All figures are daily averages in m.g.d.

Table 68 - Summary of Water Needs - WRPA 6[1/]

Use	1970	1980		2000		2020	
		National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Municipal	8.1	9.1	9.8	11.4	11.9	14.7	16.2
Industrial	61.5	71.3	78.9	135.9	157.2	261.3	306.8
Thermoelectric	0.3	82.3	97.1	547.8	575.1	649.8	713.5
Rural Domestic	6.7	5.2	5.6	3.9	4.0	2.7	2.9
Total WRPA	76.6	167.9	191.4	699.0	748.2	928.5	1,039.4

[1/] All figures are daily average withdrawals in m.g.d.

W R P A 7

DESCRIPTION

General

WRPA 7 comprises a drainage area of 6,574 square miles and occupies all or part of 17 counties (see Figure 8). The western boundary of the area is the east bank of the Mississippi River from the southern drainage divide of the Buffalo River to the northern drainage divide of the Big Black River. The southern and eastern boundaries of the area are the hydrological divide of the Homochitto River and the hydrological divide of the Pearl River Basins, respectively. The northern boundary is the hydrological divide of the Big Black and the Yazoo River Basins.

The Big Black River Basin comprises the northern portion of the WRPA, lying within a "Hill Section" of Mississippi. The topography of this area is characterized by belted layers of geologic deposits that range from rolling to hilly. Land surface elevations vary from about 60 feet m.s.l., at the confluence of the Big Black and Mississippi Rivers, to more than 500 feet m.s.l. along the eastern divide of the basin. The highest and most rugged terrain is found in the upper reaches of the eastern tributaries of the Big Black River.

The southern portion of WRPA 7 consists of the basin of streams located in the southwest corner of Mississippi. Runoff is carried by three major streams - the Buffalo River, the Homochitto River, and Bayou Pierre. Most of the drainage in this area comes from the "hill area," with some drainage occurring from a small strip of alluvial valley along the Mississippi River being interlaced with swamplands, lakes, and agricultural lands. Other tributaries in the basin are Washout Bayou, St. Catherine Creek, and Coles Creek.

Climate

The climate in the WRPA is generally mild, with normal seasonal temperature variations. Summers are long, hot, and humid; winters are short and moderate. During winter months, the prevailing wind is from the north and northwest. During other seasons prevailing winds are from the south and southwest. The average annual temperature is 64° F. Average monthly temperatures range from 50° F. in the winter to 80° F. in the summer.

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Rainfall throughout the area averages 52 inches annually. Monthly rainfall averages range from 2.1 inches in October to 5.6 inches in March, with the period from November to May incurring an average of 5 inches per month. Snowfall occurs about once a year in the northern portion, averaging about 2 inches.

Economy

The population of the WRPA has declined continuously from 177,900 in 1950 to 156,500 in 1970; this is about 2.5 percent of the total population for the Lower Mississippi Region. In 1970, 58 percent of the population of the WRPA was serviced by some form of central water system. The total population of the WRPA is projected to be 217,000 or 254,000 by the year 2020, depending on whether the National Income or Regional Development Objective is realized.

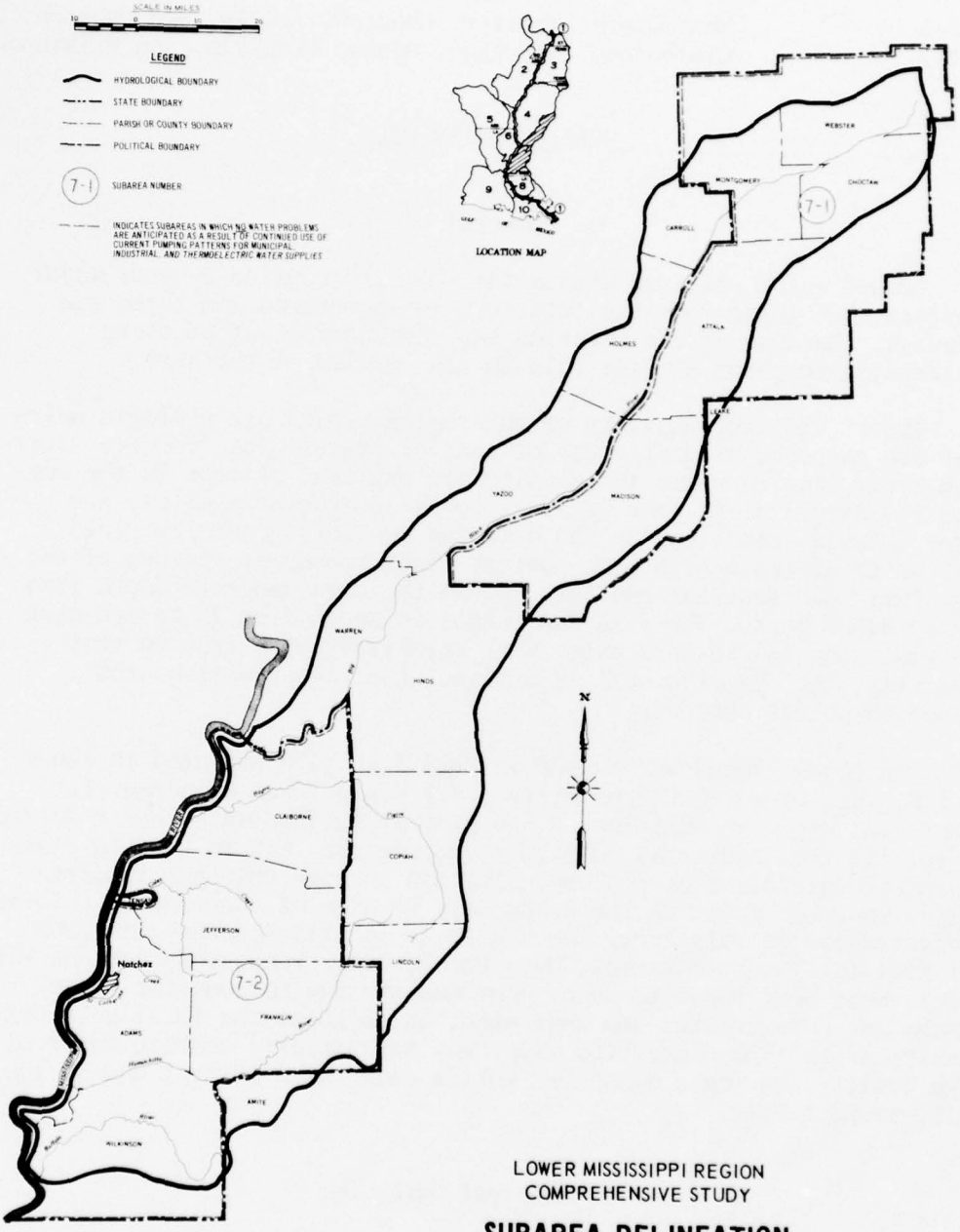
In 1967, manufacturing employment was 12,800, approximately 84 percent of which was production workers. The total payroll for the area's 290 manufacturing firms was $64.2 million. Although agricultural employment has been declining steadily since 1950, it still represents the major employment industry within the area.

Agriculture is the largest single industry in the area in terms of employment. Primary water-using manufacturing industries are paper and allied products, mining, food and kindred products, and chemical and allied products. Other industrial water users within the WRPA are textile mill products, petroleum and related products, and primary metals.

There is presently only one thermoelectric power plant located within WRPA 7. Data for 1970 show that this plant does not generate sufficient electric power to meet the WRPA's load requirements. Additional electric power is currently being imported.

Subarea Delineation

To facilitate a more comprehensive and meaningful appraisal of WRPA 7, it has been divided into two subareas. This breakdown is based on the hydrologic drainage basins within the WRPA modified to conform to county boundaries (see Figure 8). The division of the WRPA into subareas will provide for the best correlation of data, and will enable more comprehensive plan formulation. The two subareas are composed as follows:



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

SUBAREA DELINEATION MUNICIPAL AND INDUSTRIAL WATER SUPPLY

WRPA 7

FIGURE 8

Subarea	Counties
7-1	Montgomery, Webster, Choctaw, Attala, and Madison.
7-2	Claiborne, Jefferson, Adams, Franklin, and Wilkinson

PRESENT WATER USE

General

Ground water utilized within the WRPA is supplied by four major aquifers. Of these four aquifers, one is unconfined and three are artesian. Because of the location and characteristics of these aquifers, each plays a major role in its portion of the WRPA.

The significant aquifers of the region, which are geologic units that are composed predominately of sand or gravel beds, receive water from percipitation where these units are exposed. Except in the outcrop (recharge) areas, the water is confined and the aquifers are under artesian conditions. The artesian aquifers generally yield soft water having a high iron content along the upper reaches of the formation. The artesian aquifers within the area range in depth from 100 to 3,500 feet. The alluvium ranges in depth from 40 to 500 feet and yields an acidic hard water with relatively high iron content. Generally, the deeper a well is drilled, the higher will be the dissolved solids contents.

The total ground water used in WRPA 7 in 1970 amounted to about 85.1 m.g.d., of which the majority (73.1 m.g.d.) was withdrawn for industrial use. In addition, 0.5 m.g.d. of surface water was required to fulfill the industrial pumpage requirements. Within the Big Black Basin, the dissolved oxygen concentration is high and the dissolved solids range from low in the headwaters to high at the mouth. Chloride concentration is relatively low except at locations downstream from oil fields. The tributaries, Hays Creek, Bear Creek, and Fourteen Mile Creek, have been found to be of poor quality due to domestic waste discharge, both treated and untreated, which keeps the fecal coliform density high. The Homochitto River and Bayou Pierre contain water of high quality, having a dissolved solids count of 0-50 mg/1 and 50-100 mg/1, respectively.

1970 Municipal Water Use

During 1970, the 70 municipal water systems within WRPA 7 utilized 12.0 m.g.d. of ground water and no surface water. During July, the peak municipal water use month in 1970, the average daily use was 14.0 m.g.d.

The population serviced by the municipal systems varied from 35 at Williamsville to 19,700 at Natchez, Miss. The municipal water systems serviced 58 percent of the area's total population. The remaining 42 percent of the population is rural, supplying its own water. The per capita pumpage for persons receiving municipal water varied from 132 to 608 gallons per day, with the average per capita pumpage for the area being 132. The per capita pumpage for rural use water depends, in part, on whether the user has an internal distribution system. In those houses having no internal system, the average pumpage is 10 GPCD, while in homes having an internal system, the average pumpage is 60 GPCD.

Municipal water pumpages by county and major users are shown in the Inventory of Facilities Appendix, under Municipal and Industrial Water Use. Table 69 gives a breakdown, by subarea, of the 1970 municipal water withdrawals.

Table 69 - 1970 Municipal Water Use - WRPA 7[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
7-1	7.0	0.0	2.6
7-2	5.0	0.0	1.9
Total WRPA	12.0	0.0	4.5

[1/] All figures are daily averages in m.g.d.

The quality of the raw intake water governs the degree of treatment required prior to use. Accordingly, the method of treatment varies widely throughout the WRPA. Treatment varies from a simple chlorinator process in some communities, to elaborate systems of chlorination, aeration, fluoridation, filtration, and pH correction in others.

1970 Industrial Water Use

Industrial activity within the WRPA during 1970 required an average daily water withdrawal of 73.6 m.g. Of that, 99.3 percent of the water used was supplied by ground water and 0.7 percent by surface water. The water intake for subarea 7-1 was 12.4 m.g.d., while the consumption was 4.2, resulting in a return flow of 66 percent. Subarea 7-2 utilized consideralby more water with an intake of 61.2 m.g.d., of which 1.8 m.g.d. was consumed and 97 percent was returned.

Included within the 290 manufacturing firms are the six major water-using industries. None of these industries, with the exception of the paper industry, is a large independent water user.

Industrial water pumpage by subarea is shown in the Inventory of Facilities Appendix, under Municipal and Industrial Water Use. Table 70 gives a breakdown by subarea of the 1970 industrial water withdrawals.

Table 70 - 1970 Industrial Water Use - WRPA 7[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
7-1	11.9	0.5	4.2
7-2	61.2	0.0	1.8
Total WRPA	73.1	0.5	6.0

[1/] All figures are daily averages in m.g.d.

The degree of treatment varies from industry to industry within WRPA 7. The quality of the raw intake water and its intended use will govern the type of treatment required for the various industrial processes. This treatment will vary from no treatment in industries using water as a cooling agent for bearings or condensers to a full treatment in the food producing industries.

1970 Thermoelectric Power Water Use

At present, there is only one thermoelectric power plant within WRPA 7. This plant, located at Natchez, Miss., utilizes ground water as its cooling source. Sufficient electric power cannot be supplied by the one plant at Natchez to meet the electrical demands of the area; therefore, additional power is supplied through the interconnected systems of the Southwest Power Pool members. Water withdrawal of the thermal power plant during 1970 was 0.99 m.g.d. with consumption being 0.55 m.g.d. for a return flow of 0.44 m.g.d. or 44.5 percent. Table 71 indicates the 1970 thermoelectric water withdrawals for WRPA 7.

Table 71 - 1970 Thermoelectric Power Water Use - WRPA 7[1/]

Subarea	Withdrawal		Total
	Ground	Surface	
Withdrawal	0.99	0.0	0.99
Consumption	0.55	0.0	0.55
Return Flow	0.44	0.0	0.44

[1/] All figures are daily averages in m.g.d.

1970 Rural Domestic Water Use

Approximately 42 percent of the population of WRPA 7 is presently served by individual water systems. In 1970, farmers and others who furnished their own water supplies withdrew about 5.2 m.g.d. from wells and springs. Table 72 summarizes the rural domestic water withdrawals for 1970. All of this water is supplied by ground water sources, and all is considered consumed.

Table 72 - 1970 Rural Domestic Water Use - WRPA 7[1/]

Subarea	Withdrawal	Consumption
7-1	2.6	2.6
7-2	2.6	2.6
Total WRPA	5.2	5.2

[1/] All figures are daily averages in m.g.d.

FUTURE WATER NEEDS

General

Future municipal and industrial water needs within WRPA 7 will be controlled by the area's population and industrial growth. The municipal water needs are further influenced by the movement of the population from rural to municipal areas and the extension and installation of centrally supplied water systems in rural areas.

The population of WRPA 7 has been declining since 1950, and this decline is expected to end between 1970 and 1980. Projections indicate that the population will continue to grow throughout the 1980-2020 period, but at rates much lower than those of the Nation or region.

Employment is projected to increase between 1970 and 2020. This increase will be at a much lower rate than the projected national or regional rates. Indications are that the area economy, which is now predominately agriculture-based, is shifting to a labor-intensive manufacturing based economy. The per capita production is forecast to show strong growth. The increased productivity will result in an increased per employee water use for industry, which in turn will result in an overall increase in the industrial water needs.

The growth that is forecast in both population and employment, coupled with the continued urbanization, will result in an increased water use through 1980. After 1980 the increase will become even more pronounced as population and employment increase and urbanization and industrial technology continue their upward trend.

Future Municipal Water Needs

The projected population growth coupled with the shift to a labor-intensive economic base will cause a municipally-oriented population. Present trends indicate that the conversion from rural self-supplied water to municipal or rural centrally supplied water will proceed so that 80 percent of the rural population is centrally serviced by 2020, and 100 percent of those living in urban areas will be municipally served by the same time.

As the population becomes municipally oriented, industrial type employment increases and per capita income goes up. This increase in affluence will, in turn, contribute to an increase in per capita water use. In 1970, the GPCD was 132; in 1980, it will have risen to 148; in 2000, to 158; and by 2020, to 170. Tables 73 and 74 summarize the future municipal water needs under the National Income and Regional Development Objectives, respectively.

Table 73 - Future Municipal Water Needs - WRPA 7[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
7-1	8.5	3.1	12.3	4.6	18.4	6.8
7-2	6.8	2.5	9.8	3.6	14.4	5.4
Total WRPA	15.3	5.6	22.1	8.2	32.8	12.2

[1/] All figures are daily averages in m.g.d.

Table 74 - Future Municipal Water Needs - WRPA 7[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
7-1	9.4	3.4	14.3	5.3	21.5	8.0
7-2	7.6	2.8	11.4	4.2	16.8	6.3
Total WRPA	17.0	6.2	25.7	9.5	38.3	14.3

[1/] All figures are daily averages in m.g.d.

The amount of water treatment needed depends on the quality of the raw water withdrawn and the ability or willingness of the users to pay for the treatment. As new central water systems are initiated, or as established systems are expanded, the type of treatment required to insure adequate water quality will vary.

Future Industrial Water Needs

The industrial activity within WRPA 7 is forecasted to continue its present growth trend. The chemical and allied products and paper and allied products are expected to show the greatest growth rates.

At present, agriculture is the largest single-earning industry in the WRPA. By the year 2000, however, it is predicted that paper and allied products will replace agriculture as the largest industry. The abundant forest land, good transportation system, high demand for paper products, and ready labor pool are expected to enhance the increase in paper production and allow for the expansion that is anticipated.

The farm is becoming more mechanized, which is reducing the farm labor requirements and is allowing the population to shift from the rural to the municipal areas. This, plus the projected growth of the industries within the WRPA, will result in an increased industrial demand on the water resources of the area. Tables 75 and 76 show the future industrial water needs for the WRPA under the National Income and Regional Development Objectives, respectively.

Because the industries within the area market a variety of products, the quality of water required varies considerably; consequently, so does the treatment required. Industrial water used only for cooling requires no special treatment. Food processing industries, however, use treatment similar to that used in the local municipal systems. In all cases, the major factors determining the treatment required now and in the future are the quality of the intake water and its intended use.

Table 75 - Future Industrial Water Needs - WRPA 7[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
7-1	22.6	7.5	60.7	19.4	146.1	45.9
7-2	82.9	2.6	174.3	4.9	363.0	9.4
Total WRPA	105.5	10.1	235.0	24.3	509.1	55.3

[1/] All figures are daily averages in m.g.d.

Table 76 - Future Industrial Water Needs - WRPA 7[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
7-1	23.1	7.6	61.4	19.8	147.3	46.7
7-2	91.8	2.9	201.6	5.7	427.8	10.9
Total WRPA	114.9	10.5	263.0	25.5	575.1	57.6

[1/] All figures are daily averages in m.g.d.

Future Thermoelectric Power Water Needs

In 1970, the water required to produce sufficient electricity for WRPA 7 was 137 m.g.d. In 1971, USGS conducted a survey of existing facilities to determine the amount of water actually utilized in the production of electricity within the WRPA. The results of this survey indicated that 0.99 m.g.d. of water was being utilized to produce electric power within the WRPA. It was also determined that there were no new plants presently under construction, but a nuclear plant is scheduled to be constructed at Grand Gulf, on the Mississippi River, before 1980. The water requirements for the plant at Grand Gulf are expected to be approximately 1.25 billion gallons per day for condenser cooling; however, water needs to operate this plant will be withdrawn from the Mississippi River (WRPA 7) and should not affect the water availability within WRPA 7.

As stated previously, the one thermoelectric plant within the WRPA does not produce sufficient electric power for the WRPA and additional power must be imported from other sources. Additional power is obtained from the interconnected systems of the Southwest Power Pool members. Table 77 shows the future thermoelectric water needs for the WRPA based upon the realization of expected trends. This table shows future thermoelectric water requirements and does not include water requirements for the future nuclear power plant.

Table 77 - Future Thermoelectric Power Water Needs - WRPA 7[1/]

	1980		2000		2020	
	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Withdrawal	55.9	73.6	397.6	462.8	473.2	554.1
Consumption	.5	.8	5.2	3.7	7.5	8.7
Return Flow	55.4	72.8	392.4	459.1	465.7	545.4

[1/] All figures are daily averages in m.g.d.

Future Rural Domestic Water Needs

It is expected that only 20 percent of the rural population will be serviced by private systems by 2020. As a result, the amount of water withdrawn under the rural domestic category will decline through 2020. Tables 78 and 79 summarize the future rural domestic water needs under the National Income and Regional Development Objectives, respectively.

Summary of Water Needs

Table 80 is a summary of municipal, industrial, thermoelectric, and rural domestic water needs within WRPA 7.

In evaluation of present resources to determine possible water supply problems, only future municipal, industrial, and thermoelectric cooling needs are considered. Future requirements for purposes, such as irrigation and other agricultural uses, are considered in other appendixes. Discussion of water shortages anticipated when considering all water uses can be found in the Plan Formulation Appendix.

The comparison of municipal, industrial, thermoelectric, and rural domestic needs to the present availability of water as described in the Regional Climatology, Hydrology and Geology Appendix reveals no problem areas within WRPA 7.

Table 78 - Future Rural Domestic Water Needs - WRPA 7[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
7-1	2.3	2.3	1.7	1.7	1.0	1.0
7-2	2.3	2.3	1.7	1.7	0.9	0.9
Total WRPA	4.6	4.6	3.4	3.4	1.9	1.9

[1/] All figures are daily averages in m.g.d.

Table 79 - Future Rural Domestic Water Needs - WRPA 7[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
7-1	2.6	2.6	2.0	2.0	1.1	1.1
7-2	2.5	2.5	2.0	2.0	1.1	1.1
Total WRPA	5.1	5.1	4.0	4.0	2.2	2.2

[1/] All figures are daily averages in m.g.d.

Table 80 - Summary of Water Needs - WRPA 7[1/]

	1970	1980		2000		2020	
		National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Municipal	12.0	15.3	17.0	22.1	25.7	32.8	38.3
Industrial	73.6	105.5	114.9	235.0	263.0	509.1	575.1
Thermoelectric	1.0	55.9	73.6	397.6	462.8	473.2	554.1
Rural Domestic	5.2	4.6	5.1	3.4	4.0	1.9	2.2
Total	91.8	181.3	210.6	658.1	755.5	1,017.0	1,169.7

[1/] All figures are daily average withdrawals in m.g.d.

W R P A 8

DESCRIPTION

General

WRPA 8 is located in southeastern Louisiana and southwestern Mississippi. It covers an area of 5,705, square miles; approximately 4,912 square miles are located east of the Mississippi river, and 793 square miles lie west of the river. The area east of the river is bounded on the north by the Buffalo River and Homochitto River Basins. The eastern, southern and western boundaries consist of the Tchefuncta River Basin, the Lake Pontchartrain shoreline, and the Bonnet Carre' Spillway upper guide levee; the east bank Mississippi River levee to the vicinity of Baton Rouge, La.; and the top of bank above Baton Rouge. The area west of the Mississippi River is bounded on the east and north by the west bank Mississippi River levee between Morganza, La., and White Castle, La. The western boundary is the east Atchafalaya Basin protection levee. The southern boundary is a line between White Castle and the east Atchafalaya Basin protection levee at the latitude of approximately 30 degrees.

Climate

The climate is characterized by short, mild winters, relatively heavy precipitation, and long, hot summers. The normal annual temperature is 67.7° F. The coldest month is January with an average normal temperature of 52.6 degrees. July and August, the hottest months, have an average normal temperature of 82.1 degrees.

The normal annual precipitation is 57.9 inches. Major storms are associated with tropical hurricanes and the passage of extra-tropical cyclones. In summer, convective thunderstorm produce intense, but highly localized, rainfall. Snowfall occurs very infrequently and in limited amounts. The normal monthly rainfall varies from 2.7 inches in October to 6.3 inches in July.

Economy

In 1970, 546,984 people, or approximately 9 percent of the Lower Mississippi Region population, resided within the economic boundaries of WRPA 8, which consists of 10 Louisiana parishes and one Mississippi county. Much of the area's population growth has centered around the Baton Rouge SMSA, which includes about 50 percent of the total population. Since 1940, the Baton Rouge SMSA has increased more than

threefold in population. The 1970 population was 58 percent urban and 42 percent rural. Cities located in WRPA 8, with populations of 10,000 or more, include Baton Rouge, Hammond, and Scotlandville. There are 13 towns with populations between 2,500 and 10,000, two unincorporated places with populations between 1,000 and 2,500 and 18 incorporated places with populations between 500 and 2,500. Approximately 78 percent of the population is served by some form of central water system. Municipal water systems serve 85 communities. The populations of these communities range between 40 and 165,963. The population of the WRPA is projected to be 1,003,000 or 1,139,000 under the National Income or the Regional Development Objective, respectively, by the year 2020.

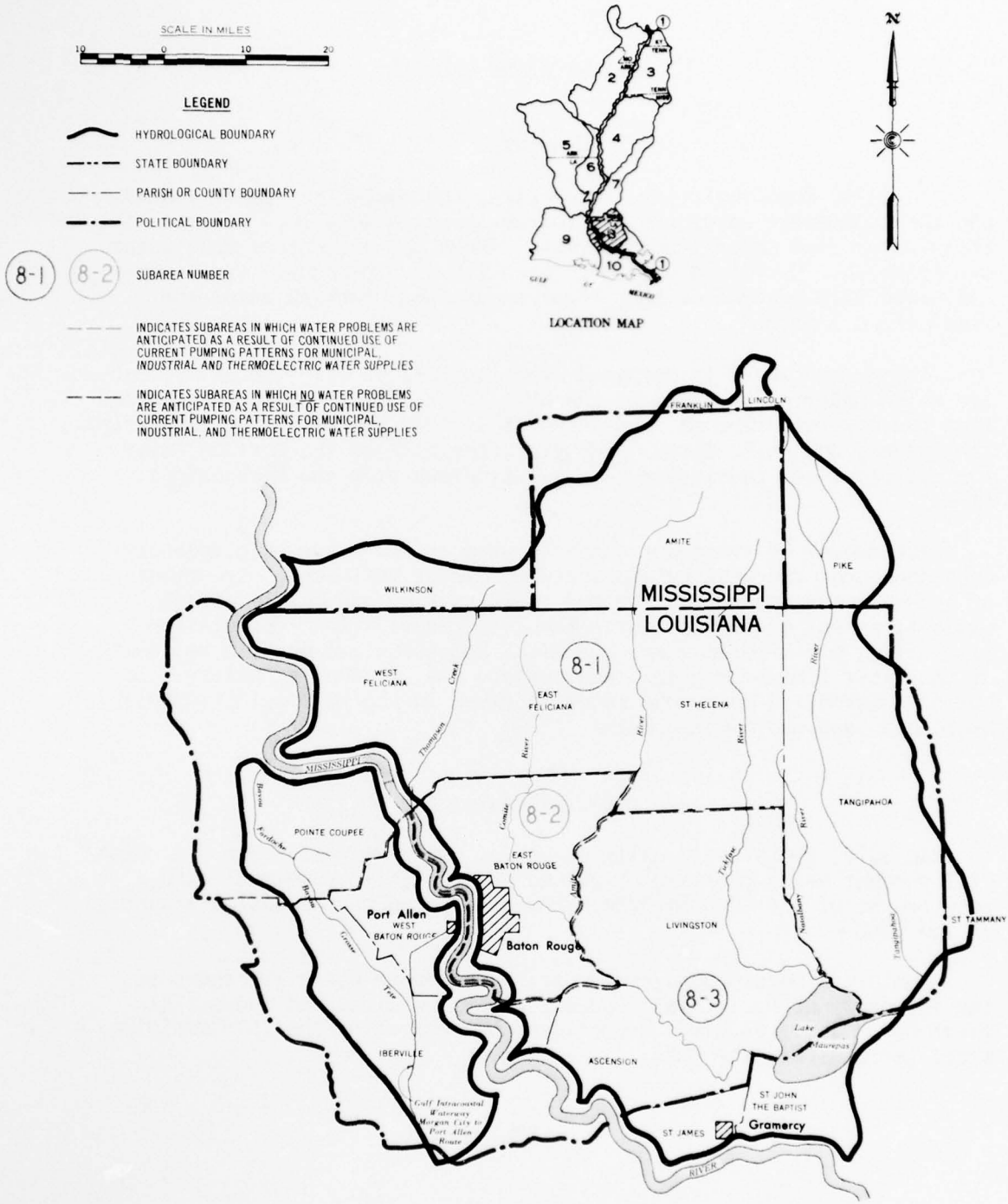
Significant economic activities in the area include processing petrochemicals and basic metals, agriculture, harvesting and processing of forest products, and waterborne commerce. In addition, the numerous streams and lakes of the area and the vast marshland and swamps comprise an enormous recreation resource. The value of mineral production in 1969 amounted to $125.7 million. The projected value of mineral production for the National Income Objective is $354.1 million in 2020. Under the Regional Development Objective, it is expected to be $449.8 million in 2020. In 1968, the gross manufacturing product was about $532 million; it is projected to increase to $5,234 million by 2020 under the National Income Objective or $6,174 million under the Regional Development Objective.

Agricultural production sold in 1970 had a value of $72.9 million. The value of production is expected to increase to $150 million in 2020 under the National Income Objective or $161 million under the Regional Development Objective. More detailed information can be found in the Economics Appendix.

Subarea Delineation

The WRPA has been modified to conform to parish boundaries, and has been divided into three subareas in order to study the area more closely. The modified area occupies 10 Louisiana parishes and one Mississippi county (see Figure 9). This breakdown will enable planners to locate problem areas more easily and will facilitate the development of a plan from the local level. The breakdown of the modified area into three subareas is as follows:

Subarea	Parish (County)
8-1	Amite, Miss.; Pointe Coupee, East and West Feliciana, St. Helena, Tangipahoa, La.
8-2	East Baton Rouge
8-3	West Baton Rouge, Ascension, Iberville, Livingston



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

SUBAREA DELINEATION MUNICIPAL AND INDUSTRIAL WATER SUPPLY

WRPA 8

FIGURE 9

PRESENT WATER USE

General

In 1970, Municipalities, industries, thermoelectric power plants, and rural domestic water users withdrew approximately 10.5 percent of their water from underground sources. About 3.3 percent of this water was brackish. Surface souces accounted for 89.5 percent. Fresh water satisfied 99.9 percent of this requirements and brackish water the remaining 0.1 percent.

The ground water is obtained from aquifers of Pliocene or Miocene age which underlay portions of the WRPA. The quality of water obtained from the aquifers is good. Fresh water is available from the Mississippi, Tangipahoa, and Amite Rivers. However, the bulk of the surface water for municipal and industrial uses is withdrawn from the Mississippi River.

The amount of treatment which is used on raw water is completely dependent upon the quality and intended use of the water. Treatment of ground water is usually limited to filtration and chlorination, while treatment of surface water involves fluoridation, coagulation filtration, and chlorination. Chemical additives are used in softening of the water from both ground and surface sources when necessary. Detailed information on ground water is given in the Regional Climatology, Hydrology and Geology Appendix.

1970 Municipal Water Use

In 1970, the average daily usage for the WRPA was 55.2 m.g.d. with 98.7 percent being supplied by ground water. This usage reflected a requirement of 129 GPCD for the WRPA as compared to the national average of 166 GPCD.

Municipal water pumpages by parish and major users are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use. Table 81 gives a breakdown by subarea of the 1970 municipal water usage within the WRPA.

Table 81 - 1970 Municipal Water Use - WRPA 8[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
8-1	10.3	0.0	3.8
8-2	39.0	0.0	14.5
8-3	5.2	0.7	2.2
Total WRPA	54.5	0.7	20.5

[1/] All figures are daily averages in m.g.d.

1970 Industrial Water Use

During 1970, the average daily industrial withdrawal was 1,514.2 million gallons, of which only 2.7 million gallons was brackish. Surface water was the primary source of supply, as it constituted 89.3 percent. The bulk of the surface withdrawals came from the Mississippi River.

The six major water users in WRPA 8 are food and kindred products, textile mill products, paper and allied products, chemical and allied products, petroleum refining, and primary metals.

Industrial water pumpages by subarea are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use. Table 82 gives a breakdown by subarea of the 1970 industrial withdrawals.

Table 82 - 1970 Industrial Water Use - WRPA 8[1/]

Sub-area	Withdrawal			Consumption
	Ground	Surface-fresh	Surface-brackish	
8-1	12.6	51.7	0.0	24.8
8-2	119.1	440.2	0.0	9.9
8-3	27.6	860.3	2.7	352.0
Total WRPA	159.3	1,352.2	2.7	386.7

[1/] All figures are daily averages in m.g.d.

1970 Thermoelectric Power Water Use

The thermoelectric plants located in WRPA 8 used a total of 588.4 m.g.d. during 1970, of which 98.5 percent was surface water. Fresh water constituted 98.7 percent of the total withdrawals. Table 83 shows the 1970 thermoelectric water usage.

Table 83 - 1970 Thermoelectric Power Water Use - WRPA 8[1/]

	Ground water		Surface water		
	Fresh	Brackish	Fresh	Brackish	Total
Withdrawal	1.3	7.5	579.6	0.0	588.4
Consumption	0.1	0.5	37.4	0.0	38.0
Return Flow	1.2	7.0	542.2	0.0	550.4

[1/] All figures are daily averages in m.g.d.

1970 Rural Domestic Water Use

In 1970, the average daily usage for the WRPA was 4.5 m.g.d. This usage reflects a requirement of 38 GPCD for the WRPA. Nearly all of the water was withdrawn from aquifers of Pliocene and Miocene age, which underlie portions of the area. Table 84 gives a breakdown by subarea of the 1970 rural domestic water usage within the WRPA.

Table 84 - 1970 Rural Domestic Water Use - WRPA 8[1/]

Subarea	Withdrawal		Consumption
	Ground water	Surface water	
8-1	2.5	0.0	2.5
8-2	0.3	0.0	0.3
8-3	1.7	0.0	1.7
Total WRPA[2/]	4.5	0.0	4.5

[1/] All figures are daily averages in m.g.d.

[2/] This excludes water flowing to waste from free-flowing wells.

FUTURE WATER NEEDS

General

The future municipal, industrial, and thermoelectric water requirements indicate a substantial increase for WRPA 8. Growth of industry and increase in population are the main reasons for the rise in water requirements; however, the larger municipal requirements are partly attributable to the continuing trend of movement to urban areas and the extension of municipally supplied water systems to rural regions.

Future Municipal Water Needs

Future estimates of municipal water needs are based on the expectation that, by the year 2020, 80 percent of the rural population will be supplied by some type of central system and 100 percent of the urban population will be municipally served.

The increase in employment and urbanization of the region affects the GPCD requirement. The rise in the affluence of the region is usually accompanied by an increase in the use of more modern appliances, plumbing, etc. This results in a larger GPCD requirement. The water use in 1970 was 129 GPCD, and is projected to rise to 141 GPCD, 159 GPCD, and 175 GPCD by the years of 1980, 2000, and 2020, respectively.

A possible problem area may occur in East Baton Rouge Parish, subarea 2, by the year 2000, if current pumping patterns are maintained, and the projected increases in ground water withdrawals are realized. At that time, municipalities which depend on ground water may need to be given priority over other ground water users; otherwise, additional water from either the Mississippi River or reservoirs in the upper region of the WRPA will be required.

Table 85 presents a breakdown of future municipal water needs by subarea under the National Income Objective (Program A).

Table 85 - Future Municipal Water Needs - WRPA 8[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
8-1	13.9	5.1	25.5	9.5	41.0	15.3
8-2	50.4	18.5	68.6	25.5	93.2	34.8
8-3	7.8	2.9	14.5	5.4	23.3	8.7
Total WRPA	72.1	26.5	108.6	40.4	157.5	58.8

[1/] All figures are daily averages in m.g.d.

Table 86 presents a breakdown of future municipal water needs by subarea to meet the Regional Development Objective (Program B).

Table 86 - Future Municipal Water Needs - WRPA 8[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
8-1	15.0	5.5	28.5	10.6	46.6	17.4
8-2	54.3	20.0	76.8	28.6	105.8	39.4
8-3	8.4	3.1	16.2	6.0	26.4	9.9
Total WRPA	77.7	28.6	121.5	45.2	178.8	66.7

[1/] All figures are daily averages in m.g.d.

Future Industrial Water Needs

Future predictions of industrial water requirements reveal that the WRPA will need 13,840.9 m.g.d. and 16,322.3 m.g.d. by the year 2020 to satisfy, respectively, the National Income and Regional Development Objectives. Of this total, 99.8 percent is expected to be supplied by fresh water sources. The percentage of intake consumed is relatively high, about 32.4 percent of the total water withdrawn. Industrial classifications expected to show the greatest growth are the chemical and allied products, paper and allied products, and petroleum refining industries.

There are no foreseeable problem areas evident at this time, since the Mississippi, Amite, and Tangipahoa Rivers afford a bountiful supply of fresh water for the WRPA. With this plentiful supply of surface and ground water available, the increasing water requirements for industrial development should be met.

Table 87 presents a breakdown of future industrial water needs by subarea to meet the National Income Objective (Program A).

Table 88 presents a breakdown of future industrial water needs by subarea to meet the Regional Development Objective (Program B).

Table 87 - Future Industrial Water Needs[1/] - WRPA 8[2/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
8-1	96.8	37.2	230.5	86.7	529.5	196.3
8-2	710.2	14.8	1,282.5	36.1	2,725.3	85.5
8-3	1,454.3	575.5	4,155.5	1,648.8	10,586.1	4,205.3
Total WRPA	2,261.3	627.5	5,668.5	1,771.6	13,840.9	4,487.1

[1/] Includes both fresh and brackish water.

[2/] All figures are daily averages in m.g.d.

Table 88 - Future Industrial Water Needs[1/] - WRPA 8[2/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
8-1	105.8	40.6	266.8	100.3	623.6	231.2
8-2	780.0	16.2	1,475.7	41.7	3,212.9	100.9
8-3	1,594.4	631.0	4,806.3	1,907.1	12,485.8	4,959.9
Total WRPA	2,480.2	687.8	6,548.8	2,049.1	16,322.3	5,292.0

[1/] Includes both fresh and brackish water.

[2/] All figures are daily averages in m.g.d.

Future Thermoelectric Power Water Needs

Thermoelectric water needs follow the trend of expected municipal and industrial use; that is, substantial increases throughout the future years. The requirements for 2020 are 5,634.0 m.g.d. and 6,394.7 m.g.d. for the National Income and Regional Development Objectives, respectively. Although these needs are somewhat high, the percentage of consumption is very small, approximately 1.6 percent, and most of the water used is returned to the source from which it was withdrawn.

No problem areas are anticipated at this time because of the available supply of surface water throughout most of the region. Two

proposed plants are expected to locate along the Mississippi River where there is an ample supply of water.

Table 89 presents the future thermoelectric power water needs for the WRPA under the National Income Objective (Program A) and under the Regional Development Objective (Program B).

Table 89 - Future Thermoelectric Power Water Needs[1/] - WRPA 8[2/]

	1980		2000		2020	
	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Withdrawal	1,257.7	1,396.1	4,747.1	5,316.8	5,634.0	6,394.7
Consumption	46.5	48.0	64.3	72.0	92.8	105.3
Return Flow	1,211.2	1,348.1	4,682.8	5,244.8	5,541.2	6,289.4

1/ Includes both fresh and brackish water.

2/ All figures are daily averages in m.g.d.

Future Rural Domestic Water Needs

Future estimates of rural domestic water needs are based on the expectation that, by the year 2020, only 20 percent of the rural population will be self-supplied and the GPCD requirement will be 80. The GPCD requirement in 1970 was 38 and is projected to rise to 46 GPCD, 63 GPCD, and 80 GPCD by the years of 1980, 2000, and 2020, respectively.

Table 90 presents a breakdown of future rural domestic water requirements by subareas under the National Income Objective (Program A).

Table 90 - Future Rural Domestic Water Needs - WRPA 8[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
8-1	2.7	2.7	3.4	3.4	4.7	4.7
8-2	0.3	0.3	0.4	0.4	0.6	0.6
8-3	1.9	1.9	2.3	2.3	3.1	3.1
Total WRPA	4.9	4.9	6.1	6.1	8.4	8.4

[1/] All figures are daily averages in m.g.d.

Table 91 presents a breakdown of future rural domestic water needs by subarea to meet the Regional Development Objective (Program B).

Table 91 - Future Rural Domestic Water Needs - WRPA 8[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
8-1	2.9	2.9	3.8	3.8	5.3	5.3
8-2	0.4	0.4	0.5	0.5	0.6	0.6
8-3	2.0	2.0	2.6	2.6	3.6	3.6
Total WRPA	5.3	5.3	6.9	6.9	9.5	9.5

[1/] All figures are daily averages in m.g.d.

Summary of Water Needs

WRPA 8 has a sufficient supply of fresh and brackish water to meet all of the municipal, industrial, thermoelectric, and rural domestic water requirements through the year 2020.

The only problem area which is foreseen at this time involves subarea 2. The problem is concerned with continuation of the present pumping pattern and giving priority to municipal and rural domestic water usage. Fresh water remains plentiful in the area.

Table 92 summarizes the municipal, industrial, thermoelectric, and rural domestic water needs for WRPA 8.

Table 92 - Summary of Water Needs[1/] - WRPA 8[2/]

Use	1970	1980		2000		2020	
		National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Municipal	55.2	72.1	77.7	108.6	121.5	157.5	178.8
Industrial	1,514.2	2,261.3	2,480.2	5,668.5	6,548.8	13,840.9	16,322.3
Thermoelectric	588.4	1,257.7	1,396.1	4,747.1	5,316.8	5,634.0	6,394.7
Rural Domestic	4.5	4.9	5.3	6.1	6.9	8.4	9.5
Total	2,162.3	3,596.0	3,959.3	10,530.3	11,994.0	19,640.8	22,905.3

[1/] Industrial and thermoelectric water needs include both brackish and fresh water.

[2/] All figures are daily average withdrawals in m.g.d.

W R P A 9

DESCRIPTION

General

WRPA 9 covers an area of 13,296 square miles in southwest Louisiana. The eastern boundary is WRPA's 1, 8, and 10. The western boundary is the Sabine River Basin. The southern boundary is the Gulf of Mexico. The northern boundary begins at the Mississippi River levee at Black Hawk and extends westward along the south bank of Red River to Boyce, Louisiana. The drainage area of WRPA 9 covers all or parts of 16 Louisiana parishes.

Climate

The climate is characterized by short, mild winters, relatively heavy precipitation, and long, hot summers. The Gulf of Mexico and numerous lakes tend to moderate temperature conditions and changes. The normal annual temperature is 68.3° F. The coldest month is January with an average normal temperature of 53.5 degrees while the hottest months, July and August, have an average normal temperature of 82.4 degrees.

The normal annual precipitation is 59.3 inches. Heavy precipitation results from such climatic actions as tropical hurricanes, extra-tropical cyclones, and intense convective thundershowers in the summer. The normal monthly rainfall varies from 3.2 inches in October to 6.0 inches in July.

Economy

In 1970, approximately 748,433 people, or about 14 percent of the Lower Mississippi Region population, resided in the 16 parishes of WRPA 9. Much of the population growth has centered around the SMSA's of Alexandria, Lake Charles, and Lafayette. Since 1940, Lafayette and Lake Charles have more than doubled in population while Alexandria has increased by more than 60 percent. Urban population as a percent of total population was 56 percent in 1970. Cities with populations of 10,000 or more include Abbeville, Alexandria, Crowley, Eunice, Jennings, Lafayette, Lake Charles, New Iberia, Opelousas, south Fort Polk, and Sulphur. There are 28 towns and three unincorporated places with population between 2,500 and 10,000, four unincorporated places between

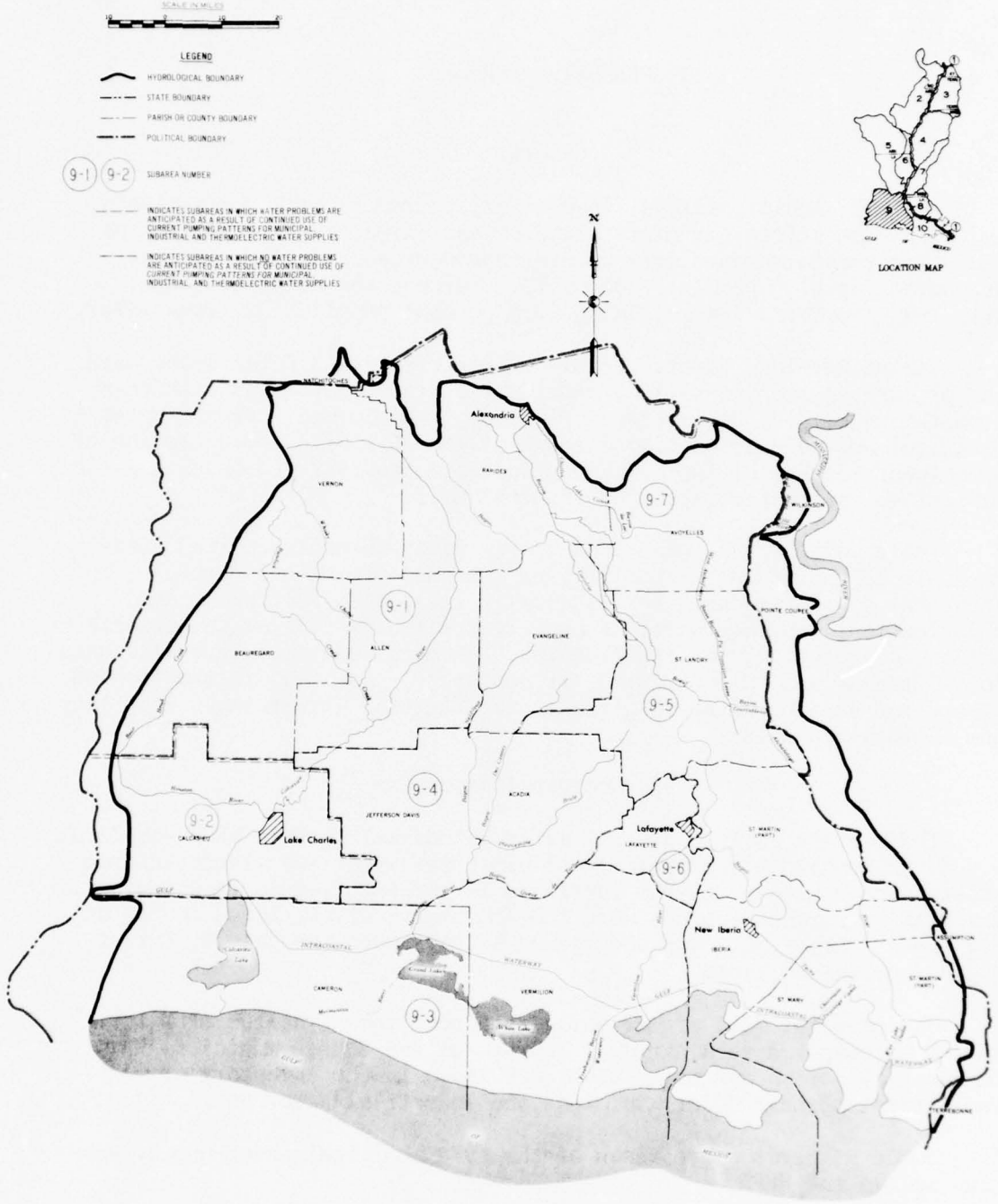
1,000 and 2,500 and 45 incorporated places with populations between 500 and 2,500. Approximately 73 percent of the population is served by some form of central water system. Municipal water systems serve 124 communities. The population of these communities range between 175 and 77,998. The population of the WRPA is projected to be 994,000 or 1,117,000 under the National Income Objective or the Regional Development Objective, respectively, by the year 2020.

Significant economic activites in the area include mineral production, petroleum and chemical processing, agriculture, commercial fishing, processing of food products, waterborne commerce, harvesting and processing of forest products, fur trapping, and service industries. In addition, the numerous lakes and streams of the area, and the vast marshland and swamps represent an enormous recreation resource. The total value of mineral production in 1969 amounted to $1.53 billion. The projected value of mineral production for the National Income Objective is $3.5 billion in 2020, or for the Regional Development Objective is $4.1 billion. In 1968, the gross manufacturing product was about $369 million. It is projected to increase in 2020 to $2,809 million under the National Income Objective or $3,315 million under the Regional Development Objective. Agricultural production in 1968 was valued at $174 million. The value of production is expected to increase 2020 to $339 million under the National Income Objective or $364 million under the Regional Development Objective. More detailed information can be found in the Economics Appendix.

Subarea Delineation

WRPA 9 has been divided into seven subareas which approximate the individual sub-basins within the WRPA, modified to conform to parish boundaries (see Figure 10). This breakdown will enable planners to better correlate data within the WRPA, and will provide small study areas where problems can be easily identified. The seven subareas are as follows:

Subarea	
9-1	Vernon, Allen, Beauregard
9-2	Calcasieu
9-3	Cameron, Vermilion
9-4	Jefferson Davis, Evangeline, Acadia
9-5	St. Landry, St. Mary, St. Martin, Iberia
9-6	Lafayette
9-7	Rapides, Avoyelles



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

SUBAREA DELINEATION MUNICIPAL AND INDUSTRIAL WATER SUPPLY

WRPA 9

FIGURE 10

PRESENT WATER USE

General

In 1970, municipalities, industries, thermoelectric power plants, and rural domestic water users withdrew approximately 19.0 percent of their water requirements from underground sources. Surface sources accounted for 81.0 percent. About 73.2 percent was obtained from brackish water, and the remaining 26.8 percent supplied by fresh water.

The Atchafalaya River, Red River, Big Creek, and Bayou Teche were the primary sources of surface water while ground water was withdrawn from the underlying Pleistocene, Pliocene, and Miocene. Ground water is plentiful and of good quality throughout the WRPA with the exception of some lower reaches of the Calcasieu and Mermentau Rivers, which are subject to salt water intrusion from the Gulf.

The amount of treatment used on raw water to meet required standards is dependent on the quality and intended use of the water. Treatment of the ground water is usually limited to filtration and chlorination. Surface water is usually treated by filtration, chlorination, coagulation, and fluoridation. Chemical additives are also used for softening and pH correction, if necessary. Detailed information on ground and surface water is given in the Regional Climatology, Hydrology and Geology Appendix.

1970 Municipal Water Use

The average daily municipal water withdrawal for the WRPA was 72.0 m.g.d. Approximately 90 percent of municipal water was withdrawn from underground sources, and the remaining 10 percent from surface sources. The primary surface sources were the Atchafalya River, Bayou Teche, and Big Creek, while the major undergound sources were the Jasper, Chicot, and Evangeline aquifers.

The usage of 72.0 m.g.d. reflects a requirement of 109 GPCD for WRPA 9 as compared to a national average of 166 GPCD. Municipal water pumpages by parish and major users are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use.

Table 93 gives a breakdown of the 1970 municipal water use by subarea within the WRPA.

Table 93 - 1970 Municipal Water Use - WRPA 9[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
9-1	5.9	0.0	2.2
9-2	17.2	0.0	6.4
9-3	3.4	0.0	1.3
9-4	5.9	0.0	2.2
9-5	10.9	5.1	5.9
9-6	10.2	0.0	3.8
9-7[2/]	11.6	1.8	5.0
Total WRPA	65.1	6.9	26.8

[1/] All figures are daily averages in m.g.d.

[2/] Subareas 7 consists of Avoyelles and Rapides Parishes removed from WRPA 5.

1970 Industrial Water Use

During 1970, the average daily industrial withdrawal was 1,301.5 million gallons, with 78.7 percent being brackish water and the remaining 21.3 percent fresh. Ground water constituted 85.8 percent of the fresh water withdrawn and virtually all of the brackish water use obtained from surface sources.

The major industrial water users are food and kindred products, textile mill products, paper and allied products, chemical and allied products, petroleum refining and primary metals. Industrial water pumpages by subarea are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use.

Table 94 gives the breakdown by subarea of the 1970 industrial water use.

Table 94 - 1970 Industrial Water Use - WRPA 9[1/]

Sub-area	Ground water		Surface Fresh Water		Surface Brackish Water	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
9-1	31.2	14.4	0.0	0.0	0.0	0.0
9-2	154.1	135.8	0.0	0.0	954.3	51.0
9-3	5.3	1.5	1.8	0.5	0.2	0.0
9-4	9.2	3.6	2/	2/	0.0	0.0
9-5	23.2	10.0	33.9	6.8	69.8	3.7
9-6	0.9	0.2	3.7	0.9	0.0	0.0
9-7	13.9	2.3	2/	2/	0.0	0.0
Total WRPA	237.8	167.8	39.4	8.2	1,024.3	54.7

1/ All figures are daily averages in m.g.d.

2/ Less than 0.05.

1970 Thermoelectric Power Water Use

Seven thermoelectric plants are located in WRPA 9 and these seven plants used a total of 336.5 m.g.d. during 1970. Approximately 97.5 percent of the water was obtained from surface sources.

Table 95 shows the 1970 thermoelectric water use by source of water.

Table 95 - 1970 Thermoelectric Power Water Use - WRPA 9[1/]

	Ground water	Surface water	Total
Withdrawal	8.5	328.0	336.5
Consumption	0.6	21.4	22.0
Return flow	7.9	306.6	314.5

1/ All figures are daily averages in m.g.d.

1970 Rural Domestic Water Use

The average daily rural domestic water withdrawal for the WRPA was 16.8 m.g.d. All of the rural domestic water was withdrawn from underground sources. The primary sources were the underlying Jasper, Chicot, and Evangeline aquifers. The usage of 16.8 m.g.d. reflects a requirement of 68 GPCD for the WRPA.

Table 96 gives a breakdown of the 1970 rural domestic water usage by subarea in the WRPA.

Table 96 - 1970 Rural Domestic Water Use - WRPA 9[1]

Subarea	Withdrawal		Consumption
	Ground water	Surface water	
9-1	2.0	0.0	2.0
9-2	0.3[2]	0.0	0.3
9-3	1.6	0.0	1.6
9-4	2.9	0.0	2.9
9-5	6.5	0.0	6.5
9-6	2.2	0.0	2.2
9-7	1.3	0.0	1.3
Total WRPA	16.8	0.0	16.8

1/ All figures are daily averages in m.g.d.

2/ Estimated.

FUTURE WATER NEEDS

General

The future municipal, industrial, and thermoelectric water requirements for WRPA 9 indicate a large increase. The bulk of this increase is due to population growth and increased industrial development. Part of the rise in principal requirements can be attributed to the continuing trend of urbanization and the extension of municipally supplied water systems to rural regions.

Future Municipal Water Needs

Future estimates of municipal water needs are based on the condition that 80 percent of the rural population will be supplied by some type of central system by the year 2020, and that by this same time, 100 percent of the urban population will be municipally supplied.

The GPCD requirement for the region is affected by employment and urbanization. Rises in these factors increase the affluence of the region and are usually accompanied by an increase in the GPCD requirement. The GPCD was 109 in 1970 and is projected to rise to 128 GPCD, 148 GPCD, and 161 GPCD by 1980, 2000, and 2020, respectively.

No special problem areas are anticipated at this time. The WRPA has a bountiful supply of fresh gound water, which is capable of meeting the future municipal requirements without any problems. Surface water is also available for additional requirements.

Table 97 presents a breakdown of future municipal water needs by subarea under the National Income Objective (Program A).

Table 97 - Future Municipal Water Needs - WRPA 9[1/]
National Income Objective (Program A)

Subarea	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
9-1	8.0	2.9	11.8	4.4	16.4	6.1
9-2	21.8	8.0	28.3	10.5	36.0	13.4
9-3	4.3	1.6	6.4	2.4	8.9	3.3
9-4	7.9	2.9	11.6	4.3	16.1	6.0
9-5	21.5	7.9	31.7	11.8	44.3	16.5
9-6	12.9	4.7	16.8	6.3	21.4	8.0
9-7	15.6	5.7	19.6	7.3	24.6	9.2
Total WRPA	92.0	33.7	126.2	47.0	167.7	62.5

[1/] All figures are daily averages in m.g.d.

Table 98 persents a breakdown of future municipal water needs by subarea under the Regional Development Objective (Program B).

Table 98 - Future Municipal Water Needs - WRPA 9[1/]
Regional Development Objective (Program B)

Subarea	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
9-1	8.5	3.1	13.3	5.0	18.5	6.9
9-2	23.3	8.6	32.1	11.9	40.5	15.1
9-3	4.6	1.7	7.2	2.7	10.0	3.7
9-4	8.4	3.1	13.1	4.9	18.1	6.8
9-5	23.1	8.5	35.9	13.4	49.8	18.6
9-6	13.8	5.1	19.1	7.1	24.0	9.0
9-7	16.5	6.1	22.2	8.3	28.0	10.5
Total WRPA	98.2	36.2	142.9	53.3	188.9	70.6

[1/] All figures are daily averages in m.g.d.

Future Industrial Water Needs

Future predictions of industrial water requirements reveal that WRPA 9 will need 10,780.8 m.g.d. or 12,714.1 m.g.d. by the year 2020 to satisfy, respectively, the National Income or Regional Development Objectives.

Brackish water satisfies 79.5 percent of the total industrial requirements. The majority of the industrial needs are in the Lake Charles area. An enormous supply of brackish water is available in this area.

Because of this virtually inexhaustible supply of brackish water, no major problem areas regarding use of this source are foreseen at this time for WRPA 9. However, the majority of the fresh water requirements are withdrawn from underground sources. Since most of the industrial usage is projected to be centered around Lake Charles, a possible shortage of groundwater could occur in this subarea about the year 2000. It would then be necessary to supplement groundwater with available surface water.

Table 99 presents a breakdown of future industrial water needs on a subarea basis to meet the National Income Objective (Program A).

Table 99 - Future Industrial Water Needs[1/] - WRPA 9[2/]
National Income Objective (Program A)

Subarea	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
9-1	57.3	24.8	136.4	61.1	310.3	142.0
9-2	1,749.5	281.7	4,083.5	626.7	9,301.2	1,358.1
9-3	8.8	2.4	13.9	3.6	23.6	5.7
9-4	13.1	5.6	27.2	12.8	57.2	29.0
9-5	193.7	28.6	435.1	57.5	986.9	120.5
9-6	5.5	1.3	8.5	2.0	15.9	3.4
9-7	19.5	3.4	40.4	8.0	87.7	18.0
Total WRPA	2,047.4	347.8	4,745.0	771.7	10,780.8	1,676.7

1/ Includes both fresh and brackish water.

2/ All figures are daily averages in m.g.d.

Table 100 presents a breakdown of future industrial water needs on a subarea basis to meet the Regional Development Objective (Program B).

Table 100 - Future Industrial Water Needs[1/] - WRPA 9[2/]
Regional Development (Program B)

Subarea	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
9-1	62.8	27.2	157.7	70.6	366.0	167.5
9-2	1,918.3	308.9	4,721.8	727.7	10,969.9	1,602.2
9-3	9.6	2.6	16.1	4.2	27.9	6.7
9-4	14.4	6.1	31.5	14.8	67.5	34.2
9-5	212.2	31.3	503.1	66.4	1,163.3	142.0
9-6	6.0	1.4	9.8	2.4	16.3	4.0
9-7	21.5	3.8	46.6	9.2	103.4	20.9
Total WRPA	2,244.8	381.3	5,486.6	895.3	12,714.3	1,977.5

[1/] Includes both fresh and brackish water.

[2/] All figures are daily averages in m.g.d.

Future Thermoelectric Power Water Needs

Future thermoelectric water requirements follow the trend set by municipal and industrial use; that is, substantial increases throughout the future years. The needs for 2020 are 3,180.1 m.g.d. or 3,582.3 m.g.d. for the National Income or Regional Development Objectives, respectively.

No special problem areas are anticipated at this time because of the available supply of ground and surface water throughout the WRPA.

Table 101 presents the future thermoelectric water needs for the WRPA, under both the National Income and the Regional Development Objectives (Programs A and B).

Table 101 - Future Thermoelectric Power Water Needs[1/] - WRPA 9[2/]

	1980		2000		2020	
	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Withdrawal	651.1	718.3	2,520.1	2,856.8	3,180.1	3,582.3
Consumption	26.3	27.1	30.6	34.6	58.4	65.8
Return Flow	624.8	691.2	2,489.5	2,822.2	3,121.7	3,516.5

[1/] Includes both fresh and brackish water.

[2/] All figures are daily averages in m.g.d.

Future Rural Domestic Water Needs

Future estimates of rural domestic water needs are based on the conditions that by the year 2020 only 20 percent of the rural population will be self-supplied and that the GPCD requirement will be 80. The GPCD was 68 in 1970 and is projected to rise to 70 GPCD, 75 GPCD, and 80 GPCD by 1980, 2000, and 2020, respectively.

Table 102 presents a breakdown of future rural domestic water needs by subareas under the National Income Objective (Program A).

Table 102 - Future Rural Domestic Water Needs - WRPA 9[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
9-1	1.8	1.8	1.8	1.8	1.7	1.7
9-2	0.3	0.3	0.3	0.3	0.3	0.3
9-3	1.4	1.4	1.4	1.4	1.4	1.4
9-4	2.6	2.6	2.5	2.5	2.5	2.5
9-5	5.8	5.8	5.7	5.7	5.7	5.7
9-6	2.0	2.0	1.9	1.9	1.9	1.9
9-7	1.2	1.2	1.1	1.1	1.2	1.2
Total WRPA	15.1	15.1	14.7	14.7	14.7	14.7

[1/] All figures are daily averages in m.g.d.

Table 103 represents a breakdown of the future rural domestic water needs by subarea to meet the Regional Development Objective (Program B).

Table 103 - Future Rural Domestic Water Needs WRPA 9[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
9-1	1.9	1.9	2.0	2.0	2.0	2.0
9-2	0.3	0.3	0.3	0.3	0.3	0.3
9-3	1.5	1.5	1.6	1.6	1.6	1.6
9-4	2.8	2.8	2.9	2.9	2.8	2.8
9-5	6.2	6.2	6.4	6.4	6.3	6.3
9-6	2.1	2.1	2.2	2.2	2.2	2.2
9-7	1.3	1.3	1.3	1.3	1.3	1.3
Total WRPA	16.1	16.1	16.7	16.7	16.5	16.5

[1/] All figures are daily averages in m.g.d.

Summary of Water Needs

The WRPA has a sufficient supply of fresh and brackish water to meet the municipal, industrial, rural domestic, and thermoelectric requirements through the year 2020.

If current pumping patterns are continued, the only problem area is subarea 2. If a problem arises, it can be resolved by the industrial water users supplementing their water requirements with surface water.

Table 104 summarizes the municipal, industrial, thermoelectric, and rural domestic water needs for WRPA 9.

Table 104 - Summary of Water Needs[1/] - WRPA 9[2/]

Use	1970	1980		2000		2020	
		National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Municipal	72.0	92.0	98.2	126.2	142.9	167.7	188.9
Industrial	1,301.5	2,047.4	2,244.8	4,745.0	5,486.6	10,780.8	12,714.3
Thermoelectric	336.5	651.1	718.3	2,520.1	2,856.8	3,180.1	3,582.3
Rural Domestic	16.8	15.1	16.1	14.7	16.7	14.7	16.5
Total WRPA	1,726.8	2,805.6	3,077.4	7,406.0	8,503.0	14,143.3	16,502.0

[1/] Industrial and thermoelectric water needs include both brackish and fresh water.

[2/] All figures are daily averages in m.g.d.

W R P A 10

DESCRIPTION

General

WRPA 10 covers an area of 7,729 square miles in extreme southeastern Louisiana. It is bounded by the Pearl River Basin on the east, WRPA 8 on the north, WRPA's 8 and 9 on the west, and the Gulf of Mexico on the south. The Mississippi River, which bisects the area, is not considered a part of WRPA 10.

Climate

The climate of WRPA 10 is characterized by short, mild winters, relatively heavy precipitation, and long, hot summers. The normal annual temperature is 69° F. The coldest month is January, with an average normal temperature of 55.1° F. July and August, the hottest months, have an average normal temperature of 82.1 degrees.

The normal annual precipitation is 62.6 inches. Major storms are associated with tropical hurricanes and passage of extra-tropical cyclones. In summer, convective thundershowers generate intense, but highly localized rainfall. The normal monthly rainfall varies from 28 inches in October to 6.5 inches in July.

Economy

In 1970, approximately 1,308,774 people, or approximately 21 percent of the Lower Mississippi Region population resided in the 11-parish economic boundary of WRPA 10. Much of the population growth of the area has centered around the New Orleans SMSA, which includes about 81 percent of the 1970 WRPA population. Since 1940, the population of the New Orleans SMSA has increased by 82 percent. The 1970 population distribution of WRPA 10 was 83 percent urban and 17 percent rural. Cities with populations in excess of 10,000 include Gretna, Harahan, Houma, Jefferson Heights, Kenner, Little Farms, Marrero, Metairie, New Orleans, Slidell, Terrytown, Thibodaux, and Westwego. There are 14 towns with populations between 2,500 and 10,000, and seven unincorporated places with populations between 500 and 2,500. Approximately 86 percent of the population is served by some form of central water system. Municipal water systems serve 37 communities. The population of these communities range between 801 and 593,471. The population of the WRPA is projected to be 2,386,000 or 2,707,000 under the National Income Objective or the Regional Development Objective, respectively, by the year 2020.

Significant economic activities in the area include mineral production, petroleum and chemical processing, agriculture, processing of food products, waterborne commerce, harvesting and processing of forest products, fur trapping, and service industries. The value of mineral production in 1969 amounted to $2.6 billion. The projected value of mineral production for the National Income Objective is $5.0 billion in 2020. Under the Regional Development Objective, the value of mineral production is expected to be $11.6 billion in 2020. In 1968, the gross manufacturing product was about $766 million. It is projected to increase to about $6.0 billion in 2020 under the National Income Objective or to approximately $7.1 billion under the Regional Development Objective.

Agricultural production sold in 1970 had a value of $36.5 million. The value of agricultural production is expected to increase to $71.9 million in 2020 under the National Income Objective or $81.0 million in 2020 under the Regional Development Objective. More detailed information can be found in the Economics Appendix.

Subarea Delineation

The WRPA has been divided into four subareas in order to study the region more closely (see Figure 11). This breakdown will enable planners to locate problem areas more easily and provide a plan which originated from the local level. The four subareas are as follows:

Subarea	Parish
10-1	Jefferson, Orleans, St. Benard, St. Tammy
10-2	Plaquemines
10-3	Assumption, Lafourche, Terrebonne
10-4	St. James, St. John the Baptist, St. Charles

PRESENT WATER USE

General

In 1970, municipalities, industries, thermoelectric power plants, and rural domestic water users in WRPA 10 satisfied approximately 1.6 percent of their requirements from ground water sources. Surface sources accounted for 98.4 percent. Fresh water satisfied 95.1 percent of this requirement and brackish water the remaining 4.9 percent.

The Mississippi River, Bayou Lafourche and the Gulf Intracoastal Waterway are the primary sources of surface fresh water. The ground water is obtained from Pleistocene and Miocene aquifers. Below the latitude of New Orleans, there is little fresh ground water due to salt water encroachment from the Gulf of Mexico. The quality of the surface

LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

SUBAREA DELINEATION MUNICIPAL AND INDUSTRIAL WATER SUPPLY

WRPA 10

FIGURE 11

water is generally good throughout the WRPA with the exception of the streams which enter the Gulf of Mexico. The saline content of the bottom reaches of these streams may be somewhat high at certain times of the year when salt water from the Gulf intrudes upstream during periods of low runoff. Ground water is good in the northeastern section of the WRPA, but salt water encroachment in the southern section causes the water to be virtually useless for public supplies.

The amount of treatment the raw water receives is dependent upon its raw quality and intended use. Treatment of ground water is usually limited to filtration, chlorination, and softening, if necessary. Surface water is generally treated by filtration, chlorination, fluoridation, and coagulation. Softening by use of lime and possible pH correction are two other methods frequently needed in the treatment of surface water.

1970 Municipal Water Use

In 1970, the average water withdrawal for the WRPA was 184.7 m.g.d. with 96.5 percent being supplied by surface water. The Mississippi River was the major source of surface water.

Underlying sands of Pleistocene and Miocene age were the source of ground water which was primarily used in St. Tammany Parish. Detailed information concerning the ground water is shown in the Regional Climatology, Hydrology and Geology Appendix.

The usage of 184.7 m.g.d. reflected a demand of 164 GPCD for the WRPA as compared to a national average of 166 GPCD.

Municipal water pumpages by parish and major users are shown in the Inventory of Facilities Appendix under Municipal and Industrial Water Use.

Table 105 gives a breakdown by subarea of the 1970 municipal water usage within the WRPA.

Table 105 - 1970 Municipal Water Use - WRPA 10[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
10-1	5.7	157.8	60.6
10-2	0.0	3.5	1.3
10-3	0.0	11.7	4.3
10-4	0.1	5.9	2.2
Total WRPA	5.8	178.9	68.4

[1/] All figures are daily averages in m.g.d.

1970 Industrial Water Use

During 1970, the industrial withdrawal averaged 2,038.7 m.g.d. with 30.9 m.g.d. being supplied by brackish water. Surface water constituted 98.7 percent of the fresh intake, with the Mississippi River serving as the primary source.

The major water users in WRPA 10 are food and kindred products, textile mill products, paper and allied products, chemical and allied products, petroleum refining and primary metals.

Industrial water pumpages by subarea are shown in the Inventory of Facilities Appendix, under Municipal and Industrial Water Use.

Table 106 gives a breakdown by subareas of the 1970 industrial water withdrawals.

Table 106 - 1970 Industrial Water Use - WRPA 10[1/]

Subarea	Withdrawal	Consumption	Surface Fresh Water Withdrawal	Surface Fresh Water Consumption	Surface Brackish Water Withdrawal	Surface Brackish Water Consumption
10-1	20.4	1.2	824.0	47.2	6.8	3.0
10-2	0.0	0.0	6.9	0.6	0.0	0.0
10-3	0.3	0.0	51.2	5.4	5.0	2.2
10-4	5.6	0.3	1,099.5	42.2	19.1	8.5
Total WRPA	26.3	1.5	1,981.6	95.4	30.9	13.7

[1/] All figures are daily averages in m.g.d.

1970 Thermoelectric Power Water Use

Thermoelectric plants located in WRPA 10 used 1,406.4 m.g.d. during 1970 with approximately 98.5 percent from surface sources. Fresh water constituted 89.8 percent of the total withdrawals.

Table 107 gives a breakdown of the thermoelectric water usage by source of water.

Table 107 - 1970 Thermoelectric Water Use - WRPA 10[1/]

	Ground Water		Surface Water		
	Fresh	Brackish	Fresh	Brackish	Total
Withdrawal	21.4	0.0	1,241.0	144.0	1,406.4
Consumption	1.3	0.0	74.1	8.6	84.0
Return Flow	20.1	0.0	1,166.9	135.4	1,322.4

[1/] All figures are daily averages in m.g.d.

1970 Rural Domestic Water Use

The average daily water withdrawal by rural domestic users was 3.5 m.g.d. All of this water was obtained from underground sources. The underlying sands of Pleistocene and Miocene age were the major source of ground water, which was primarily used in St. Tammany Parish. The usage of 3.5 m.g.d. reflected a demand of 22 GPCD for the WRPA.

Table 108 gives a breakdown by subarea of the 1970 rural domestic usage.

Table 108 - 1970 Rural Domestic Water Use - WRPA 10[1/]

Subarea	Withdrawal		Total consumption
	Ground water	Surface water	
10-1	3.2	0.0	3.2
10-2	0.0	0.0	0.0
10-3	2/	2/	2/
10-4	0.3	0.0	0.3
Total WRPA	3.5	0.0	3.5

[1/] All figures are daily averages in m.g.d.

[2/] Less than 0.05 m.g.d.

FUTURE WATER NEEDS

General

The future municipal, industrial, and thermoelectric water requirements for WRPA 10 are expected to show a large increase. The bulk of

this increase is due to population and industrial growth; however, the increase in municipal use is also related to the continuing trend of movement to urban areas and the extension of municipally supplied water systems to rural regions.

Future Municipal Water Needs

Future estimates of municipal water needs are based on the expectation that, by the year 2020, 80 percent of the rural population will be supplied by some type of central system and 100 percent of the urban population will be municipally supplied.

Rises in employment and urbanization in the WRPA will tend to increase the level of affluence. It may be accompanied by increased usage of more modern appliances, plumbing, and etc., which usually results in a larger GPCD requirement. The GPCD was 164 in 1970 and is projected to rise to 170 GPCD, 179 GPCD and 195 GPCD in 1980, 2000, and 2020, respectively.

No problem areas are foreseen at this time. The Mississippi River, which flows through the region, carries an abundant supply of fresh water for municipal use.

Table 109 presents a breakdown of future municipal water needs by subareas under the National Income Objective (Program A).

Table 109 - Future Municipal Water Needs - WRPA 10[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
10-1	195.4	71.9	275.3	102.4	380.0	141.7
10-2	4.0	1.5	5.3	2.0	7.1	2.7
10-3	13.8	5.1	19.4	7.2	27.1	10.1
10-4	7.1	2.6	10.1	3.7	14.0	5.2
Total WRPA	220.3	81.1	310.1	115.3	428.2	159.7

[1/] All figures are daily averages in m.g.d.

Table 110 presents a breakdown of future municipal water needs by subarea to meet the Regional Development Objective (Program B).

Table 110 - Future Municipal Water Needs - WRPA 10[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
10-1	210.8	77.6	307.0	114.2	431.2	160.8
10-2	4.4	1.6	6.0	2.2	8.1	3.0
10-3	14.9	5.5	21.7	8.1	30.7	11.5
10-4	7.7	2.8	11.2	4.2	15.9	5.9
Total WRPA	237.8	87.5	345.9	128.7	485.9	181.2

[1/] All figures are daily averages in m.g.d.

Future Industrial Water Needs

Future predictions of industrial water requirements reveal that the WRPA will need 18,426.5 m.g.d. or 21,731.4 m.g.d. by the year 2020 to satisfy, respectively, the National Income or Regional Development Objectives. Of this total, 98.5 percent must be supplied by fresh water sources. Although the requirements for 2020 are extremely high, the percentage of consumption is only 4.4 percent. Because of this small percentage of consumption, most of the water withdrawn will be returned. Yet, there must be an ample supply of water which is capable of meeting the withdrawal requirements, regardless of the amount which is returned. Industrial classifications expected to show the greatest growth are the chemical and allied products, petroleum refining and food kindred products industries which are the major water-using industries.

There appears to be one serious problem area in WRPA 10. Subarea 3, Lafourche, Terrebonne, and Assumption Parishes, may not have sufficient water to meet its predicted industrial needs beyond 1980. Good ground water is virtually non-existent in the region and surface water is dependent upon Bayou Lafourche, which receives its water from the Mississippi River via a pumping station, owned and operated by the Lafourche Fresh Water District, located at Donaldsonville, La. The installed capacity of this pumping station is 193.8 m.g.d., which compares to the projected demands of 67.6 - 73.8 m.g.d. in 1980.

The Mississippi River is a readily available source for all of the other areas except St. Tammy Parish; however, the Tchefuncta River and a plentiful supply of ground water in subarea 10-1 are present in that parish.

Table 111 gives a breakdown of future industrial water needs by subareas under the National Income Objective (Program A).

Table 111 - Future Industrial Water Needs[1/] - WRPA 10[2/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
10-1	1,153.3	74.3	2,239.9	170.8	4,420.8	584.7
10-2	11.3	0.0	32.7	2.3	84.4	5.6
10-3	67.6	9.3	109.9	15.8	187.2	27.9
10-4	1,839.9	73.2	5,325.3	170.3	13,734.1	386.9
Total WRPA	3,072.1	157.7	7,707.8	359.2	18,426.5	805.1

1/ Includes both fresh and brackish water.

2/ All figures are daily averages in m.g.d.

Table 112 presents a breakdown of future industrial water needs by subarea to meet the Regional Development Objective (Program B).

Table 112 - Future Industrial Water Needs [1/] - WRPA 10[2/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
10-1	1,264.3	81.4	2,590.6	197.6	5,213.5	453.7
10-2	12.3	1.0	37.8	2.6	99.5	6.5
10-3	73.8	10.2	127.3	18.2	220.3	32.8
10-4	2,016.7	80.2	6,159.3	196.9	16,198.1	456.2
Total WRPA	3,367.1	172.8	8,915.0	415.3	21,731.4	949.2

1/ Includes both fresh and brackish water.

1/ All figures are daily averages in m.g.d.

Future Thermoelectric Power Water Needs

Thermoelectric water use follows the trend set by municipal and industrial use, with substantial increases throughout the future years. The requirements for 2020 are 6,229.2 m.g.d. or 7,070.1 m.g.d. for the National Income or Regional Development Objectives, respectively. The percentage of consumption, as in the industrial use, is very small and most of the water used will be returned to the source from which it was withdrawn.

No problems are expected if future plants will locate along the Mississippi River or other sources of sufficient water supply.

Table 113 presents the future thermoelectric power water needs for the WRPA under both National Income and Regional Development Objectives (Programs A and B).

Table 113 - Future Thermoelectric Power Water Needs[1/] - WRPA 10[2/]

	1980		2000		2020	
	National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Withdrawal	2,058.8	2,242.0	5,184.8	5,781.1	6,229.2	7,070.1
Consumption	105.6	107.5	105.6	107.5	105.6	118.0
Return Flow	1,953.2	2,134.5	5,079.2	5,673.6	6,123.6	6.952.1

[1/] Includes both fresh and brackish water.

[2/] All figures are daily averages in m.g.d.

Future Rural Domestic Water Needs

Future estimates of rural domestic water needs are based on the expectation that, by the year 2020 only 20 percent of the rural population will be self supplied, and the GPCD requirement will be 80. The GPCD was 22 in 1970 and is projected to rise to 33 GPCD, 57 GPCD, and 80 GPCD in 1980, 2000, and 2020, respectively.

Table 114 presents a breakdown of future rural domestic water needs by subareas under the National Income Objective (Program A).

Table 114 - Future Rural Domestic Water Needs - WRPA 10[1/]
National Income Objective (Program A)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
10-1	4.9	4.9	5.7	5.7	4.7	4.7
10-2	0.0	0.0	0.0	0.0	0.0	0.0
10-3	0.0	0.0	0.0	0.0	0.0	0.0
10-4	0.5	0.5	0.5	0.5	0.4	0.4
Total WRPA	5.4	5.4	6.2	6.2	5.1	5.1

[1/] All figures are daily averages in m.g.d.

Table 115 presents a breakdown of future rural domestic water needs by subarea to meet the Regional Development Objective (Program B).

Table 115 - Future Rural Domestic Water Needs - WRPA 10[1/]
Regional Development Objective (Program B)

Sub-area	1980		2000		2020	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
10-1	5.3	5.3	6.4	6.4	5.2	5.2
10-2	0.0	0.0	0.0	0.0	0.0	0.0
10-3	0.0	0.0	0.0	0.0	0.0	0.0
10-4	0.5	0.5	0.6	0.6	0.5	0.5
Total WRPA	5.8	5.8	7.0	7.0	5.7	5.7

[1/] All figures are daily averages in m.g.d.

Summary of Water Needs

The WRPA, in general, has a sufficient supply of fresh and brackish water to meet the projected municipal, industrial, and thermoelectric requirements through the year 2020.

The only problem area foreseen at this time is in subarea 10-3, Terrebonne, Lafourche, and Assumption Parishes.

Table 116 summarizes the municipal, industrial, thermoelectric, and rural domestic requirements for WRPA 10.

Table 116 - Summary of Water Needs[1/] - WRPA 10[2/]

Use	1970	1980		2000		2020	
		National Income	Regional Development	National Income	Regional Development	National Income	Regional Development
Municipal	184.7	220.3	237.8	310.1	345.9	428.2	485.9
Industrial	2,038.8	3,072.1	3,367.1	7,707.8	8,915.0	18,426.5	21,731.4
Thermoelectric	1,406.4	2,058.8	2,242.0	5,184.8	5,781.1	6,229.2	7,070.1
Rural Domestic	3.5	5.4	5.8	6.2	7.0	5.1	5.7
Total WRPA	3,633.4	5,356.6	5,852.7	13,208.9	15,049.0	25,089.0	29,293.1

1/ Industrial and thermoelectric water needs include both brackish and fresh water.

2/ All figures are daily average withdrawals in m.g.d.

WATER RESOURCES PLANNING AREAS